SKG123ND规格书
双频组合导航模块
SKG123ND Datasheet
Dual Frequency Integrated
Navigation Module

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V1.01	初始版本/Initial version	Wilson	20220826
V1.02	更新通信接口描述/ Update the communication interface description	Wilson	20220921
V1.03	更新引脚定义描述/Update the pin definition description	Bennett	20221227
V1.04	增加备份电池注意事项和更新引脚说明/Add the backup battery notes and update pins description	George	20230110
V1.05	更新 PPS 和通信频率/Update the PPS and communication frequency	Bennett	20230309

目录/**Contents**

1 产品简介/Product Introduction

　　SKG123ND 是一款高性能的面向车载导航领域的车载组合导航模块，模块包含高性能的同时支持 GPS、北斗、GLONASS、Galileo、QZSS 的卫星接收机芯片、支持 L1+L5 双频定位、三轴陀螺仪、三轴加速度等；通过在线的自适应组合导航算法，SKG123ND 提供实时高精度的车辆定位、测速和测姿信息，在 GNSS 系统的信号精度降低甚至丢失卫星信号时，不借助里程计信息，SKG123ND 利用纯惯性导航技术，也可在较长时间内单独对汽车载体进行高精度定位、测速和测姿。

SKG123ND is a high-performance vehicle-mounted integrated navigation module for the field of vehicle-mounted navigation. The module contains a high-performance chip which supporting GPS, Beidou, GLONASS, Galileo, QZSS satellite reception and L1+L5 dual-frequency positioning, three-axis gyroscope, three-axis acceleration, etc. Through the online adaptive integrated navigation algorithm, the SKG123ND provides real-time and high-precision vehicle positioning, speed measurement and attitude measurement information. When the signal precision of GNSS system decreases or even the satellite signal is lost, SKG123ND utilizes pure inertial navigation technology without resorting to odometer information. It can also carry out high-precision positioning, speed measurement and attitude measurement on the vehicle carrier alone for a long time. The module can directly output the total mileage, which is convenient for customers to measure mileage.

图 1：SKG123ND 正视图/Top view

2 典型应用/Applications

◆ 车辆高精度导航/High precision vehicle navigation

◆ 公交车智能交通/Intelligent transportation of buses

◆ 车辆远程监控/Remote vehicle monitoring

3 产品特点/Features

◆ 具备驾驶行为告警功能（如急加减速，碰撞、快速变道等）

◆ 高性能三轴陀螺仪和三轴加速度计/High performance three axis gyroscope and three axis accelerometer

◆ 完成正交误差，温度漂移等误差补偿/Complete orthogonal error, temperature drift error compensation

◆ 紧凑模块化设计可节省用户产品空间/Compact modular design can save user product space

◆ 即插即用的标准通信协议 NEMA0183/Plug and play standard communication protocol NEMA0183

◆ 无安装角度要求方便用户车载安装/No installation Angle is required to facilitate vehicle-mounted installation

◆ 支持 RTCM2.3-3.3 协议/Supports RTCM2.3-3.3 protocols

◆ 复杂环境亚米级导航/Sub-meter navigation in complex environment

◆ 符合 RoHS, FCC, CE /Compliance with RoHS, FCC, CE

4 产品优点/Product Advantages

◆ 消除陀螺漂移获高精度姿态航向信息/High precision attitude heading information was obtained by eliminating gyro drift

◆ 消除震动加速度获高精度速度信息/High precision velocity information is obtained by eliminating vibration acceleration

◆ 零速修正算法可防止导航数据漂移/Zero - speed correction algorithm can prevent navigation data drift

◆ 基于自适应的扩展卡尔曼滤波算法/Extended Kalman Filter algorithm based on adaptive

◆ 识别并隔离有较大误差的 GNSS 数据/Identify and isolate GNSS data with large errors

◆ 利用纯惯性导航实现高精度定位/High precision positioning is realized by pure inertial navigation

◆ 组合导航和纯惯导航技术自主切换/Autonomous switch between integrated navigation and pure inertial navigation technology

5 电气特性/Electrical specification

◆ 极限参数/limit Parameter

参数/Parameter	符号/Symbol	最小值/Min.	最大值/Max.	单位/Unit
电源/power supply				
供电电压/Supply Voltage	VCC	-0.3	3.6	V
输入输出/ IO				
I/O 特性/I/O Features	VIO	-0.3	3.6	V
RF 输入功率/RF Input power	RF_IN		0	dBm
静电保护/ESD	RF_IN		2000	V
环境/Environment				
存储温度/Storage temperature	Tstg	-40	85	°C
湿度/Humidity			95	%

◆ 电气特性/Electrical specification

参数/Parameter	符号/Symbol	条件/Condition	最小值/Min.	典型值/Type	最大值/Max.	单位/Unit
电源电压/Supply voltage	VCC		3.0	3.3	3.6	V
电源电压/Supply voltage	V_BCKP		2.2	3.0	3.6	V
输入高压/input high voltage	VIH		2.4		3.6	V
输入低压/input low voltage	VIL		0		0.6	V
输出高压/output high voltage	VOH	Ioh=4mA	2.8			V
输出低压/output low voltage	VOL	Iol=4mA			0.4	V
工作温度/Operating temperature	Topr		-40		85	°C

注：本产品内部有复杂的组合导航算法，所以功耗比一般的导航模块高，请在设计硬件电路过程中，一定给本产品预留足够的功耗，即电流不小于 150mA。

Note：This product has a complex integrated navigation algorithm, so the power consumption is higher than that of ordinary navigation modules. Please reserve enough power consumption for this product during the design of hardware circuit, that is, the current is not less than 150mA.

V_BCKP 注意事项/ V _ BCKP Considerations：

1. V_BCKP 电压不可低于推荐工作电压的最小值，否则模块无法正常工作。

1. The V _ BCKP voltage shall not be lower than the minimum value of the recommended operating voltage, otherwise the module cannot work normally.

2. 在 Continuous 模式下，V_BCKP 最大耗流为 100μA，这将使电池逐渐耗尽，因此不推荐使用不可充电电池。

2. In Continuous mode, the maximum flow consumption of V _ BCKP is 100 μ A, which will gradually exhaust the battery, so it is not recommended Electric battery.

3. 请根据电池的充电电流选择合适的电阻。

3. Select the appropriate resistance according to the charging current of the battery.

4. 建议通过 MCU 来控制模块的 V_BCKP，以便在模块进入异常状态时重新启动模块。

4. It is recommended that the V _ BCKP of the module be controlled through the MCU to restart the module when the module enters an abnormal state.

6 性能指标/Performance evaluation

◆ 电气特性一倍标准差（1σ）GNSS 部分功能/Electrical characteristics one standard deviation (1 σ) GNSS partial function

参数/Parameter	描述/Description		
接收机类型/Receiver type	L1	1602 MHz	GLONASS L1OF
		1575.42 MHz	GPS L1CA QZSS L1CA SBAS L1 QZSS L1 SAIF Galileo E1 (E1B+E1C)
		1561.098 MHz	BeiDou B1l
	L5	1176.45 MHz	GPS L5 QZSS L5

| | | | Galileo E5a |
			BeiDou B2a
TTFF	冷启动/Cold Start：28s		
	温启/Warm Start：28s		
	热启动/Hot Start：1s		
	辅助启动/Auxiliary start：5s		
灵敏度/Sensitivity	跟踪/Tracking：-165dBm		
	捕获/Acquisition：-160dBm		
	冷启动/Cold Start：-148dBm		
	温启/Warm Start：-148dBm		
	热启动/Hot Start：-156dBm		
水平定位精度/Horizontal positioning precision	自主定位/Autonomous positioning：1.2m		
	SBAS：1m		
PPS	20ns		
速度精度/Speed precision	0.05m/s		
航向精度/Course accuracy	0.3degrees		
操作限制/Operational constraint	动态/Dynamic<=4g		
	高度/Altitude<=50,000m		
	速度/Speed<=500m/s		

7 管脚定义/PIN Definition
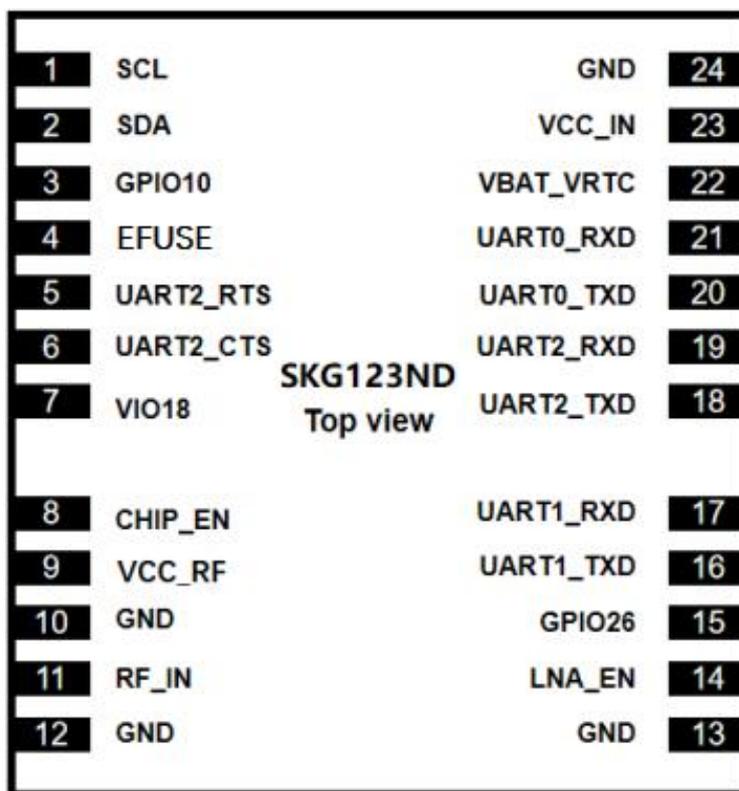
图 3：SKG123ND 管脚定义/pin definitions

8 管脚描述/Pin description

管脚编号 /Pin No.	管脚定义/Pin name	IO	使用说明/Description	电压/Voltage(±5%)
1	SCL	DI	GPIO2：I2C_SCL/I2C 串行时钟	+2.8V
2	SDA	DIO	GPIO3：I2C_SDA/I2C 串行数据	+2.8V
3	GPIO10	DO	GPIO10：PPS 秒脉冲信号输出/Second pulse signal output	+2.8V
4	EFUSE	P_IN	eFuse 供电/eFuse power source	+1.8V
5	UART2_RTS	DO	GPIO0：UART2_RTS	+2.8V
6	UART2_CTS	DI	GPIO1：UART2_CTS	+2.8V
7	VIO18	P_out	DC1.8V Output/1.8V 电源输出	+1.8V
8	CHIP_EN	DI	模块复位，低电平有效/Module reset, active low	+2.8V

9	VCC_RF	P_out	有源天线供电端输出/Active antenna power output	VCC
10	GND	G	电源地/Ground	GND
11	RF_IN	AI	GNSS 天线接口	/
12	GND	G	电源地/Ground	GND
13	GND	G	电源地/Ground	GND
14	LNA_EN	DO	GPIO32；外部 LNA 使能输出	+1.8V
15	GPIO26	DIO	GPIO26	+2.8V
16	UART1_TXD	DO	GPIO17；UART1_TXD	+1.8V
17	UART1_RXD	DI	GPIO16；UART1_RXD	+1.8V
18	UART2_TXD	DO	GPIO6；UART2_TXD；备用串口发送/Standby serial port transmission	+2.8V
19	UART2_RXD	DI	GPIO5；UART2_RXD；备用串口接收/Standby serial port reception	+2.8V
20	UART0_TXD	DO	GPIO7；UART0_TXD；串口发送/Serial	+2.8V
21	UART0_RXD	DI	GPIO8；UART0_RXD；串口接收/Serial	+2.8V
22	VBAT_VRTC	P_in	备份电池/Backup battery：2.2V--3.6V	2.2V--3.6V
23	VCC_IN	P_in	工作电压/Operating voltage：3.0-3.6V	3.0-3.6V
24	GND	G	电源地/Ground	GND

9 机械尺寸/Machine Dimension
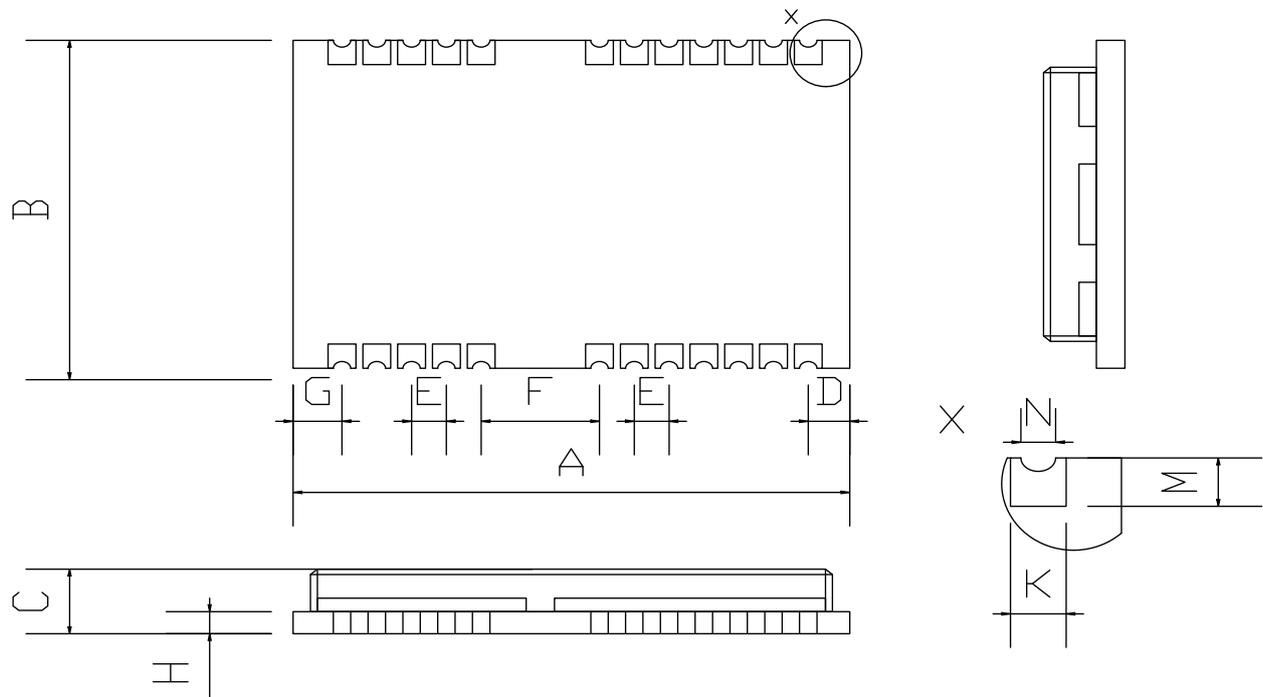
Symbol	Min.(mm)	Type(mm)	Max.(mm)
A	15.9	16.0	16.6
B	12.1	12.2	12.3
C	2.2	2.4	2.6
D	0.9	1.0	1.3
E	1.0	1.1	1.2
F	2.9	3.0	3.1
G	0.9	1.0	1.3
H	0.7	0.8	0.9
M	0.7	0.8	0.9
N	0.8	0.9	1.0
K	0.4	0.5	0.6
Weight	1.6g		

图 4：SKG123ND 机械尺寸/Machine Dimension

10 参考电路/Reference circuit
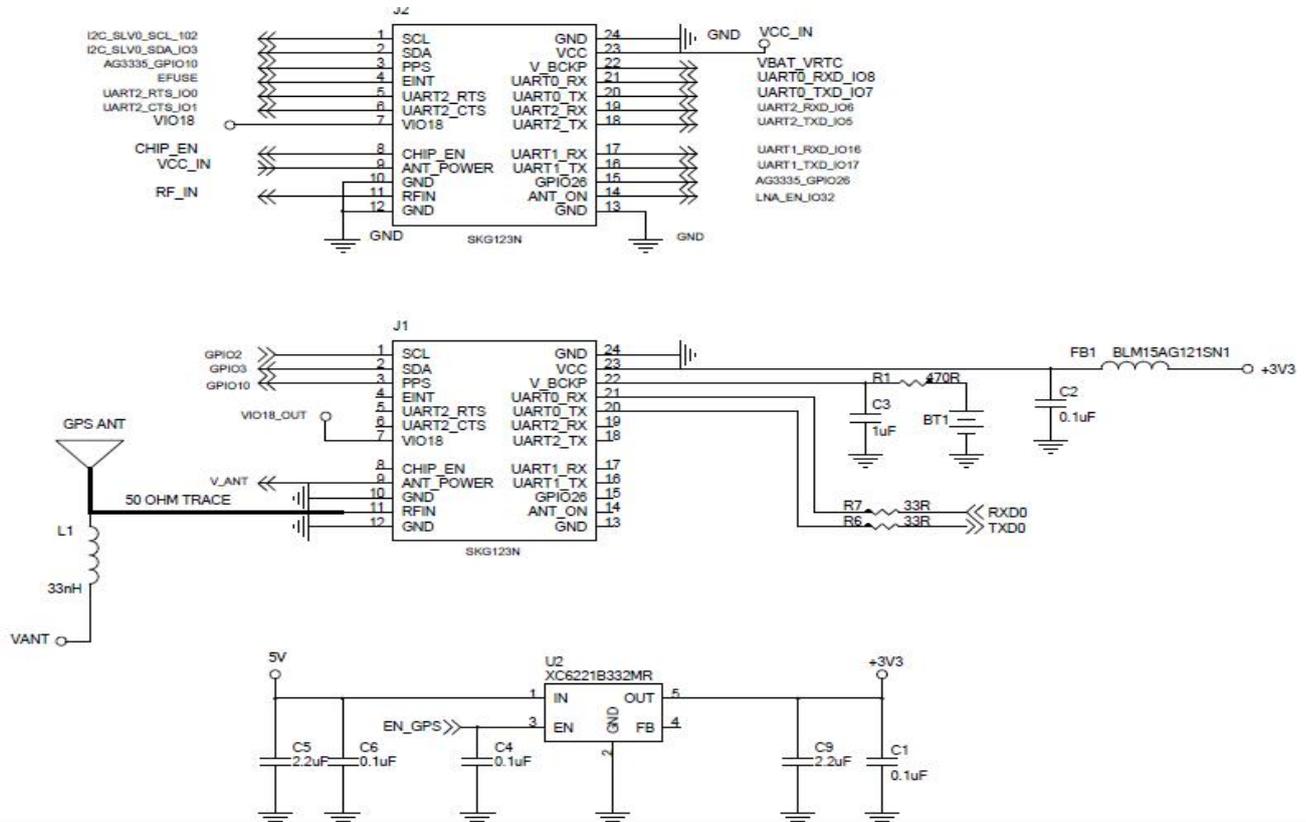
图 5：SKG123ND 参考电路//Reference circuit

11 使用说明/Operation instruction

◆ 传感标定/Sensor calibration

由于芯片制造工艺等问题，每个 SKG123ND 的各个传感器组件（三轴陀螺仪、三轴加速度计）的零点、灵敏度和温漂等参数都不一样，为了使每个 SKG123ND 达到相同的性能指标，出厂前已经对 SKG123ND 的各个传感器组件进行了各种误差补偿。

Due to the chip manufacturing process and other problems, each SKG123ND sensor components (three-axis gyroscope, three-axis accelerometer) zero, sensitivity and temperature drift parameters are not the same, in order to make each SKG123ND to achieve the same performance indicators, the SKG123ND sensor components have been a variety of error compensation.

◆ 通信接口/Communication interface

SKG123ND 模块提供了两个串口，其中串口 0 用于发送卫星信息，串口 2 用于输入、输出差分信息。

The SKG123ND module provides two serial ports. Serial port 0 is used to send satellite information and receive differential information, and serial port 2 is used to input and output differential information.

两个串口都不提供硬件握手方式，且采用 8 位数据位、0 位奇偶校验位，1 位停止位（8-N-1）方式，波特率默认为 115200,可根据用户要求，修改波特率。

The SKG123ND module provides two serial ports. Serial port 1 is used to send satellite information and receive difference information, and serial port 2 is used to receive odometer information and input and output difference information.

◆ 通信频率/**Frequency of communication**

目前，系统支持输出 1hz 的数据刷新频率。

Currently, the system supports the output data refresh frequency of 1hz.

12 注意事项/Matters need attention

SKG123ND 模块作为一款高性能的车载组合导航系统，在使用过程中，也需要用户注意一些使用事项，如表：

As a high-performance vehicle-mounted integrated navigation system, SKG123ND module also requires users to pay attention to some matters during use, as shown in the following table:

表 12-1/ Table 12-1

序号/No.	准备工作/Preparatory work	重要性/Importance degree
1	上电前，需要安装牢靠，安装时无具体安装角度要求，自适应； Before powering on the device, ensure that it is securely installed. There is no specific installation Angle requirement and it is self-adaptive.	必须/Must
2	上电前，固定连接车体和 SKG123ND，模块无摇晃； Before the device is powered on, the car body is fixedly connected to SKG123ND, and the module does not shake;	必须/Must
3	上电后，不能再移动 SKG123ND； After the device is powered on, the SKG123ND cannot be moved.	必须/Must
4	车体移动前，确保用户 GPS/BD 系统输出规定的协议 Before moving, make sure the user's GPS/BD system outputs the specified protocol	必须/Must

表 12-2/ Table 12-2

序号 /No.	组合导航初始化过程/Composite navigation initialization process	重要性/Importance degree
1	上电后，静止 5-10 秒以上，完成导航系统的姿态初始化； After the device is powered on, hold for more than 5-10 seconds to complete the attitude initialization of the navigation system.	必须/Must
2	行驶过程中，在道路上有加减速操作和左右转弯，以便识别安装角。 After 2 minutes of driving, accelerate and decelerate operation on straight road in order to identify mounting Angle.	必须/Must
3	待语句$PAIRMSG,90 中的状态标志变为 3 时表示训练完成，即可进入复杂环境（如车库、隧道）注：语句详情在 13.6 Enter complex environment (e.g. garage, tunnel) after 5-10 minutes of driving	必须/Must
4	每次上电重复上面 1、2、3 步骤 After powering on again, you can omit the step of straight acceleration and deceleration to identify the installation Angle (see table No. 2).	

　　组合导航模块初始化过程，建议车辆首先在无遮挡的环境下行驶大约几分钟，然后再进入有遮挡环境下，组合导航模块的定位效果才会好。

During the initialization process of the integrated navigation module, it is suggested that the vehicle should first run in a non-sheltered environment for about a few minutes, and then enter a sheltered environment, so that the positioning effect of the integrated navigation module will be good.

13 语句解析/Statement parsing

13.1 NMEA 0183 协议/ NMEA 0183 Protocol

表 13.1-1 NMEA-0183 输出信息/ Nmea-0183 Output information

NMEA 协议	描述	默认
GGA	定位数据信息	打开
GSA	当前卫星信息	打开
GSV	可见卫星信息	打开
RMC	推荐定位信息	打开

表 13.1-2 标识符助记码/ Table 13.1-2 Identifier mnemonics

标识符/Identifier	数据类型/Data type
GB	北斗模式/ Beidou Model
GP	GPS 模式/ GPS Model
GL	GLONASS 模式/ GLONASS Model
GA	GALILEO 模式/ GALILEO Model
GN	多模模式/ Dual-mode Model

13.2 GGA -定位数据信息/ GGA - Location Data Information

此语句包含定位位置、定位时间、定位精度。

This statement contains location, location time, and location accuracy.

$GNGGA,023344.000,2233.6896,N,11405.3616,E,2,73,0.38,24.0,M,-1.9,M,,*5D

表 13.2-1 GGA 语句格式/ Table 13.2-1 GGA statement formats

名称/Name	示例/Example	单位/Unit	描述/Description
语句 ID/Statement ID	$GNGGA		表明语句为 GGA 信息
UTC 时间	023344.000		hhmmss.sss 时分秒格式
纬度/Latitude	2233.6896		ddmm.mmmm 度分格式
纬度/Latitude	N		N=北纬 S=南纬/ N=Northern latitude S=South latitude
经度/Longitude	11405.3616		dddmm.mmmm 度分格式
经度/Longitude	E		E=东经 W=西经/ E=East Longitude W=West Longitude
定位状态/ Positioning state	2		见附表 9.2-2/ See the table 9.2-2
已使用卫星数量/ Number of satellites in use	73		范围 0 到 24/ The range is from 0 to 24
HDOP 水平精度因子/HDOP horizontal precision factor	0.38		
海拔高度/ Level	24.0	米/M	
大地水准面高度/Geoidal height	-1.9	米/M	
校验值/Proof test value	*5D		
EOL	<CR> <LF>		结束标志符/ End identifier

表 13.2-2 定位状态描述/ Table 13.2-2 Location status description

数值/Value	描述/Description
0	未定位或定位信息不可用/ No location or location information is unavailable
1	GNSS 定位模式/ GNSS fix
2	伪距差分模式/ D-GNSS,SBAS
3	PPS 模式/ PPS
6	惯性导航模式/INS

13.3 GSA -当前卫星信息/ GSA - Current satellite information

此条语句包含模块的选定工作模式，定位类型，已使用卫星的 PRN 信息及 PDOP, HDOP, VDOP 等信息。

$GNGSA,A,3,196,195,19,20,199,06,11,17,12,05,09,194,0.63,0.38,0.50,1*01

表 13.3-1 GSA 语句格式/ Table 13.3-1 GSA statement formats

名称/Name	示例/Example	单位/ Unit	描述/Description
语句 ID/ Statement ID	$GNGSA		表明语句为 GSA 信息
模式 1/ Mode 1	A		表 9.3-3/ Table 9.3-3
模式 2/ Mode 2	3		表 9.3-2/ Table 9.3-2
已使用卫星 ID 信息/ ID information about the satellite in use	196		第一信道的 Sv 信息/ Sv information of the first channel
已使用卫星 ID 信息/ ID information about the satellite in use	195		第二信道的 Sv 信息/ Sv information of the second channel
…	…		…
已使用卫星 ID 信息/ ID information about the satellite in use	<Null>		十二信道的 Sv 信息（未使用则为空）/Sv information for twelve channels (null if not in use)
PDOP	0.63		综合位置精度因子/ Synthesize position accuracy factor
HDOP	0.38		水平精度因子/ Horizontal accuracy factor
VDOP	0.50		垂直精度因子/ Vertical precision factor
校验值/Proof test value	1*01		
EOL	<CR> <LF>		结束标志符/ End identifier

表 13.3-2/ Table 13.3-2

值/Value	描述/Description
1	未定位/ Not locate
2	2D 定位/ 2D position
3	3D 定位/ 3D positioning

表 13.3-3/ Table 13.3-3

值/Value	描述/Description
M	手动选择 2D 或者 3D 模式/ Manually select 2D or 3D mode
A	自动选择 2D 或者 3D 模式/ Automatically select 2D or 3D mode

13.4 GSV -可见卫星信息/ GSV - Visible satellite information

此语句包含可见卫星的 PRNs，方位角和仰角等信息。

This statement contains PRNs, azimuth and elevation of the visible satellite.

$GPGSV,5,1,18,196,70,097,45,195,62,066,45,19,60,093,46,20,60,262,44,1*63

$GBGSV,8,1,29,22,77,103,46,10,69,232,39,07,65,197,42,61,64,189,,1*7B

表 13.4-1 GSV 语句格式/Table 13.4-1 GSV statement formats

名称/Name	示例/Example	单位/ Unit	描述/Description
语句 ID/ Statement ID	$GPGSV		表明此语句为 GSV 信息/ Indicates that the statement is GSV information
GSV 总数信息/Indicates the total number of GSVS	4		本次 GSV 语句的总条数/ Total number of GSV statements
GSV 条数信息	1		本条语句为 GSV 语句中的第几条/ Order in GSV statements
可见卫星信息/ Visible satellite information	18		当前可见卫星总数/ Total number of currently visible satellites
卫星 ID/ Satellite ID	196		
卫星仰角/ Satellite elevation angle	70	度/Degrees	范围 00 到 90/ The range is 00 to 90
卫星方位角/ Satellite Azimuth	097	度/Degrees	范围 000 到 359/ The range is 000 to 359
信噪比(C/NO)	45	dB-Hz	范围 00 到 90（未使用则为空）/ Range 00 to 90 (null if not in use)
…			…
卫星 ID/ Satellite ID	20		

卫星仰角 Satellite elevation angle	60	度/Degrees	范围 00 到 90/ The range is 00 to 90
卫星方位角/ Satellite Azimuth	262	度/Degrees	范围 000 到 359/ The range is 000 to 359
信噪比(C/NO)	44	dB-Hz	范围 00 到 90（未使用则为空）/ Range 00 to 90 (null if not in use)
校验值/Proof test value	*63		
EOL	<CR> <LF>		结束标志符/ End identifier

13.5 RMC -推荐定位信息/ RMC - Recommended Location Information

此语句包含推荐定位的卫星定位信息。

This statement contains satellite location information for the recommended location.

$GNRMC,023344.000,A,2233.6896,N,11405.3616,E,0.03,154.65,130822,,,D,V*05

表 13.5-1: RMC 语句格式/ Table 13.5-1: RMC statement formats

名称/Name	示例/Example	单位/ Unit	描述/Description
语句 ID/ Statement ID	$GNRMC		表明此语句为 RMC 信息/ Indicates that the statement is RMC information
UTC 时间	023344.000		hhmmss.sss
使用状态/ User state	A		A=数据已使用 V=数据未使用/ A= Data in use V= Data not in use
纬度/Latitude	2233.6896		ddmm.mmmm 度分格式
纬度/Latitude	N		N=北纬 S=南纬/ N=Northern latitude S=South latitude
经度/Longitude	11405.3616		dddmm.mmmm 度分格式
经度/Longitude	E		E=东经 W=西经/ E=East Longitude W=West Longitude
速度/Speed	0.03	节/Paragraph	
方位角/Azimuth	154.65	度/Degrees	
UTC 日期	130822		ddmmyy
磁偏角/Declination	<Null>	度/Degrees	未使用则为空/Null if not in use
磁偏角方位/Magnetic declination azimuth	<Null>		E=东经 W=西经/ E=East Longitude W=West Longitude
定位模式/ Positioning Mode	D		A=自动, N=未定位, D=DGPS, E=DR/ A= automatic, N= unlocated, D=DGPS, E=DR
校验值/Proof test value	*05		

EOL	<CR> <LF>		结束标志符/ End identifier

13.6 $PAIRMSG,90 –惯导相关信息- DR Related Information

此语句包含惯导相关信息。

$PAIRMSG,90,023344.000,3*59

表 13.6-1: PAIRMSG,90 语句格式/ Table 13.6-1: PAIRMSG,90 statement formats

名称/Name	示例/Example	单位/ Unit	描述/Description
语句 ID/ Statement ID	$PAIRMSG,90		表明此语句为 DR 信息/ Indicates that the statement is RMC information
UTC 时间	023344.000		hhmmss.sss
惯导状态/ DR state	3		
校验值/Proof test value	*59		
EOL	<CR> <LF>		结束标志符/ End identifier

表 13.6-2/ Table 13.6-2

值/Value	描述/Description
0	未知/DR_Solution_Unkonw
1	初始化/ DR_Solution_Init
2	粗略估计/ DR_Solution_Coarse
3	稳定状态/ DR_Solution_Stable

13.7 $PAIRMSG,91 –VMDS 相关信息- DR Related Information

此语句包含惯导相关信息。

$PAIRMSG,91,023344.000,1,0*46

表 13.7-1: PAIRMSG,90 语句格式/ Table 13.7-1: PAIRMSG,90 statement formats

名称/Name	示例/Example	单位/ Unit	描述/Description
语句 ID/ Statement ID	$PAIRMSG,91		表明此语句为 DR 信息/ Indicates that the statement is RMC information
UTC 时间	023344.000		hhmmss.sss
动态/ Dynamic state	1		
警报状态	0		
校验值/Proof test value	*46		
EOL	<CR> <LF>		结束标志符/ End identifier

表 13.7-2/ Table 13.7-2

值/Value	描述/Description
0	未知/ Unknown
1	静态/ Static
2	动态/ Dynamic

表 13.7-3/ Table 13.7-3

值/Value	描述/Description
0	未知/ Unknown
1	猛踩油门/HARSH_ACCELERATION
2	猛踩刹车/HARSH_DECELERATION
4	猛打方向盘/HARSH_TURN
8	车道变化/HARSH_LANE_CHANGE
16	碰撞/HORIZONATAL_WARNING
32	车辆翻转/ROLLOVER
64	失稳警告/STABILITY_WARNING
128	EULER_ANOMALY

14 联系方式/ Contact Information

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