SKM-6DM规格书
双频组合导航模块
SKM-6DM Datasheet
Dual Frequency Integrated Navigation Module

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目录/Contents

1 产品简介/Product Introduction

SKM-6DM 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，SKM-6DM 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，SKM-6DM 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。模块可以直接输出总里程数，方便客户进行里程计量。

SKM-6DM 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 SKM-6DM 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, SKM-6DM 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：SKM-6DM 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

- 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
- 每个产品标定参数均不一致防盗版/Each product calibration parameters are inconsistent anti-piracy
- 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 设计原理/Design diagram

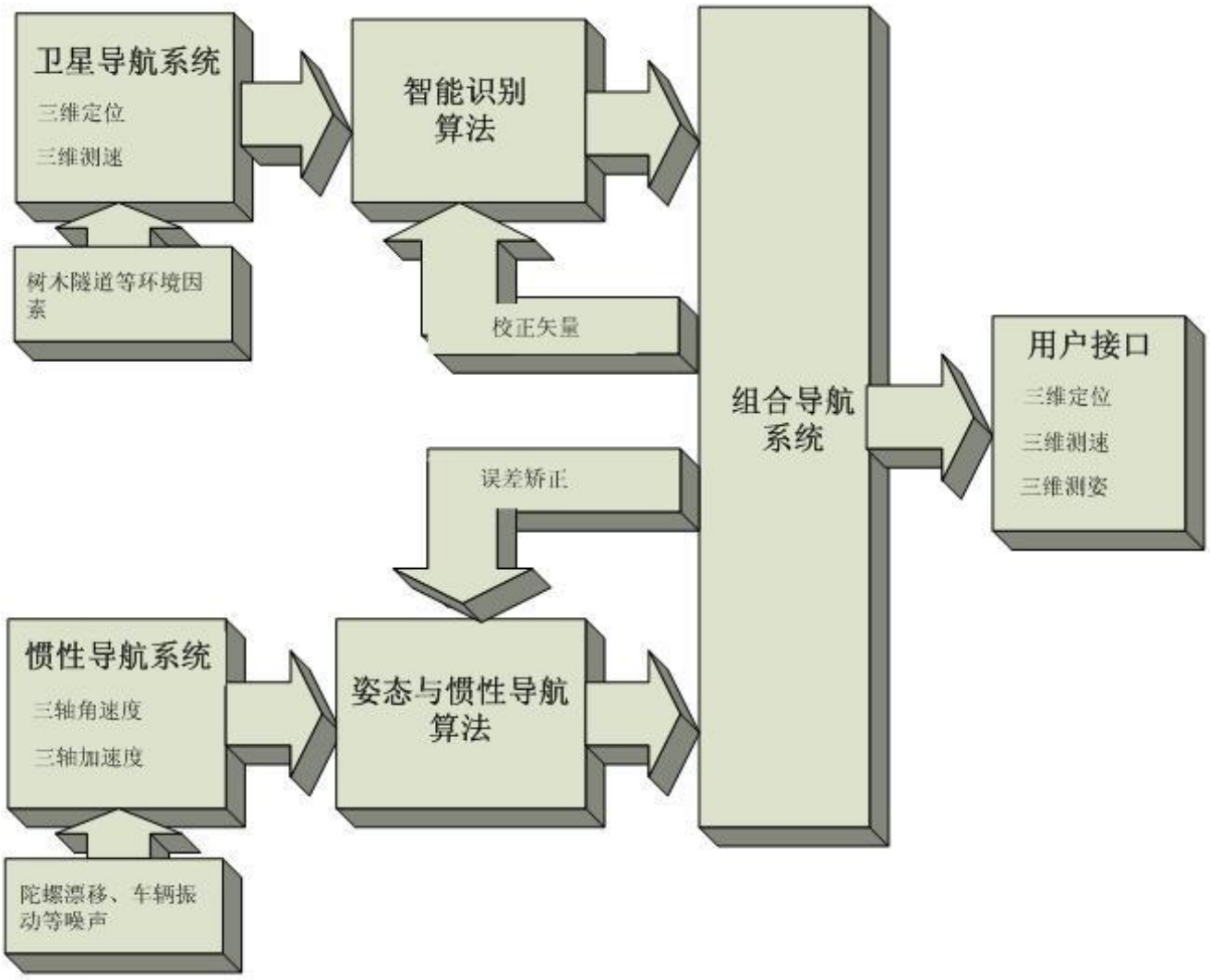


图 2：SKM-6DM 设计原理框图/Design diagram

5.1 基础原理/Rudiment

◆ 卫星导航系统/Satellite navigation system：

卫星导航系统具有实现全球、全天候、高精度的导航等优点；但卫星导航系统容易受到周围环境的影响，例如树木楼房等，造成多路径效应，使得定位结果精度降低甚至丢失，尤其是在隧道或者室内环境中，卫星导航系统基本无法使用。另外，即使在空旷的环境下，当载体速度非常低时，卫星导航系统获得载体方位信息（航向角）也会产生较大误差。

Satellite navigation system has the advantages of realizing global, all-weather and high-precision navigation. However, the satellite navigation system is susceptible to the influence of the surrounding environment, such as trees and buildings, resulting in multipath effect, which reduces the accuracy of the positioning results and even

loses them. Especially in the tunnel or indoor environment, the satellite navigation system cannot be used basically. In addition, even in the open environment, when the carrier speed is very low, the satellite navigation system to obtain the carrier azimuth information (heading Angle) will produce a large error.

◆ 惯性导航系统/Inertial navigation system：

惯性导航是以牛顿力学定律为基础，通过测量载体在惯性参考系的加速度，将它对时间进行积分，且把它变换到导航坐标中，就能够得到在导航坐标中的速度、偏航角和位置等信息，同时可以获得载体的载体信息。但惯性导航系统由于陀螺仪零点漂移严重，车辆震动等因素，致使无法通过直接积分加速度获得高精度的方位和速度等信息，即现有的微惯性导航系统很难长时间独立工作。

Inertial navigation is based on Newtonian mechanical laws, by measuring the acceleration of the carrier in the inertial reference system, integrating it with time, and transforming it into navigation coordinates, the information of velocity, yaw Angle and position in the navigation coordinates can be obtained, and the carrier information can be obtained at the same time. However, due to the serious gyroscope zero drift, vehicle vibration and other factors, the inertial navigation system can not directly integrate the acceleration to obtain high precision azimuth and speed information, that is, the existing micro-inertial navigation system is difficult to work independently for a long time.

◆ 组合导航系统/Integrated navigation system：

卫星和惯性组合导航充分利用惯性导航系统和卫星导航系统优点，基于最优估计算法—卡尔曼滤波算法融合两种导航算法，获得最优的导航结果；尤其是当卫星导航系统无法工作时，利用惯性导航系统使得导航系统继续工作，保证导航系统的正常工作，提高了系统的稳定性和可靠性。

The advantages of inertial navigation system and satellite navigation system are fully utilized, and the optimal navigation results are obtained by integrating the two navigation algorithms based on the optimal estimation algorithm -- Kalman filter algorithm. Especially when the satellite navigation system can not work, the use of inertial navigation system to make the navigation system continue to work, ensure the normal operation of the navigation system, improve the stability and reliability of the system.

◆ 摆脱里程计/Get rid of the speedometer：

常规车载导航系统往往依靠里程计和陀螺仪的 DR 方案，实现汽车复杂环境下的高精度导航定位，里程计信号对于很多汽车后装市场而言，连接非常复杂，而且涉及汽车安全问题。经过多年的研发，在 GNSS 系统的信号精度降低甚至丢失卫星信号时，SKM-6DM 系统完全摆脱了对里程计依赖，仅仅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，与市场上现有的相关产品相比，性能得到了较大地提升。当然，SKM-6DM 模块可以连接里程计信号，将会获得更好的性能指标。

Conventional vehicle-mounted navigation systems often rely on the DR scheme of odometer and gyroscope to achieve high-precision navigation and positioning in complex automotive environments. Odometer signals are very complicated to connect to many automotive rear-installation markets, and involve automotive safety issues. After years of research and development, in signal accuracy of GNSS system to reduce or even the loss of satellite signal, SKM - 6 dm system completely get rid of the dependence on odometer, just using pure inertial navigation technology, can also be used for a long time separate car carrier for high-precision positioning, velocity and position, compared with the existing related products on the market, significantly improved its performance. Of course, the SKM-6DM module can be connected to the odometer signal, which will achieve better performance indicators.

◆ 车辆姿态角/Vehicle attitude Angle：

SKM-6DM 导航模块利用多年对 MEMS 惯性器件的研究经验，通过自适应滤波算法实现了对陀螺仪漂移和加速度震动信号的滤波，并进一步可以获得高精度的姿态信息，从而可以满足坡道检测等车辆监控和导航应用的各种需求。

SKM-6DM navigation module uses years of MEMS inertial device research experience, through the adaptive filtering algorithm to achieve the gyro drift and acceleration vibration signal filtering, and can further obtain high-precision attitude information, so as to meet the requirements of vehicle monitoring and navigation applications such as ramp detection.

◆ GI 导航系统/GI navigation system：

SKM-6DM 导航模块提出了卫星导航精度的智能识别算法，基于组合导航提供的高精度导航信息，对卫星导航的定位精度进行识别，如果卫星导航精度较好，则进行组合导航，一旦发现卫星导航信号非常差甚至丢失信号，则进行纯惯性导航，总之，SKM-6DM 导航模块实现了组合导航和纯惯性导航的自主切换。

SKM-6DM navigation module satellite navigation precision of the intelligent identification algorithm is proposed, based on high precision navigation information, provided by the integrated navigation of satellite navigation and positioning accuracy, which can identify if the satellite navigation precision is good, is to carry on the integrated navigation, once found very poor even lost satellite navigation signal, the pure inertial navigation, in short, Skm-6dm navigation module realizes the autonomous switch between integrated navigation and pure inertial navigation.

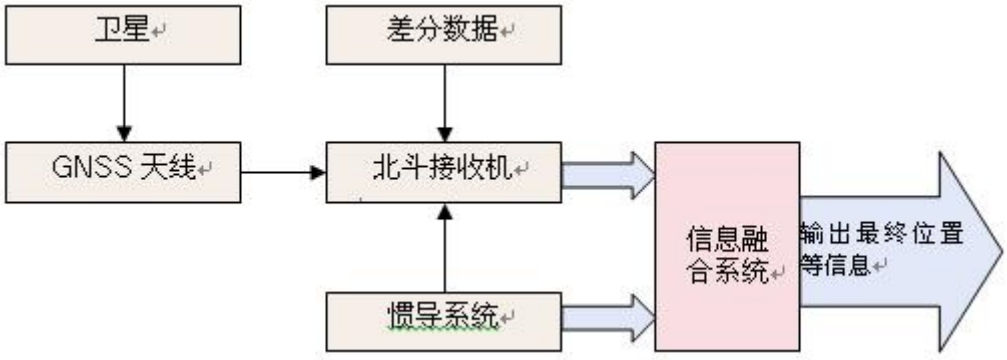
5.2 技术方案/Technical proposal

◆ 基于差分系统，获得 RTCM2.3-3.3 的差分数据，SKM-6DM 可实现伪距差分，在空旷环境下可以实现亚米级的定位精度，该模块同时也具备输出 RTCM；

Based on the difference system, the difference data of RTCM2.3-3.3 can be obtained. Skm-6dm can realize pseudo-distance difference and sub-meter positioning accuracy can be achieved in open environment. The module also has RTCM output.

◆ 基于惯性导航的组合定位方式，实现在复杂环境下的车辆导航定位，从而可以实现在高架下，高楼林立，树木遮挡等环境下的公交车高精度导航定位。

The combined positioning method based on inertial navigation can realize vehicle navigation and positioning in complex environment, so as to realize high-precision bus navigation and positioning under elevated, tall buildings, trees and other environments.



5.3 方案说明/Programme narratives

◆ **差分高精度/Differential precision**

SKM-6DM 是基于 AG3335 设计的高精度定位模块，当接收到差分数据之后，在空旷环境下可以达到 0.8 米 rms 的定位精度，但是一旦达到复杂环境下，主要由惯性导航技术提高定位精度。

SKM-6DM is a high-precision positioning module designed based on AG3335. After receiving differential data, the positioning accuracy can reach 0.8m RMS in open environment, but once it reaches complex environment, the positioning accuracy is mainly improved by inertial navigation technology.

◆ **惯性导航/Inertial navigation**

惯性导航是和卫星导航一样，惯性导航系统都是一直在工作，惯性导航输出三维位置、三维速度、三维姿态、三维加速度、三维角速度等 15 维车载信息；卫星导航系统输出三维位置和三维速度等 6 维信息。

Inertial navigation is the same as satellite navigation, inertial navigation system is always working, inertial navigation output three-dimensional position, three-dimensional velocity, three-dimensional attitude, three-dimensional acceleration, three-dimensional angular velocity and other 15-dimensional vehicle-mounted information; The satellite navigation system outputs 6-dimensional information such as three-dimensional position and three-dimensional speed.

1）组合导航的初始化过程：惯性导航没有初始信息，必须通过卫星导航复制给惯性导航初始位置和速度方向等信息，所以需要车辆跑起来，形成车辆行驶的方向，完成初始化。

1) Initialization process of integrated navigation: inertial navigation has no initial information, which must be copied to inertial navigation through satellite navigation, such as initial position and speed direction, so the vehicle needs to run to form the direction of the vehicle to complete initialization.

2）组合导航的误差求解：组合导航系统利用卫星和惯性导航输出的三维位置和三维速度的差值，对惯性导航的三维姿态、三维加速度和三维角速度进行求解，同事求解出三轴加速度计和三轴陀螺仪的各种误差，这些误差是白噪声，即没有任何统计规律，是随着时间随机变化，必须通过 kalman 滤波算法实时求解更新才可以获得最优解。

2) Error solution of integrated navigation: Integrated navigation system using satellite and inertial navigation output three-dimensional position and the three dimensional velocity difference, 3 d of inertial navigation attitude, are applied to solve the three dimensional acceleration and the three dimensional velocity colleagues to solve a three-axis accelerometer and various error of three-axis gyroscope, the error is white noise, namely no statistical rule, is random changes over time, The optimal solution can be obtained only by real-time kalman filtering algorithm.

3）组合导航的训练时间：根据上述分析，组合导航系统需要通过卫星导航求解惯性导航的各种误差，所以，必须有一个训练过程，即用高质量的卫星导航来训练惯性导航的性能，使得惯性导航可以估计出自身的误差，如果训练时间很短，则无法实现很好的性能。

3) Integrated navigation training time: according to the above analysis, the integrated navigation system needs by various error of inertial navigation, satellite navigation solution, therefore, must have a training process, which USES the high quality of the performance of the inertial navigation satellite navigation to training, make the error of inertial navigation can estimate the oneself, if the training time is very short, can achieve good performance.

4）组合导航的自适应算法：车辆在城市行驶过程中，有空旷环境下、有复杂环境，还有隧道车库等环境，组合导航算法有一套卫星质量评估算法，根据卫星质量来进行组合导航，通俗的讲，就是根据卫星质量来确实，卫星和惯性导航之间的比例系数，例如，空旷环境下，100%相信卫星导航，车库隧道，100%相信惯性导航，以此类推。

4) Adaptive algorithm of integrated navigation: Vehicles in the process of urban driving, have open environment, complex environment, and the tunnel garage environment, such as integrated navigation algorithm has a satellite quality assessment algorithm, according to the satellite quality for integrated navigation, popular, is indeed, according to the satellite quality coefficient of the ratio between the satellite and inertial navigation, for example, open environment, 100% believe in satellite navigation, Garage tunnels, 100% inertial navigation, and so on.

5.4 定位性能/Positioning performance

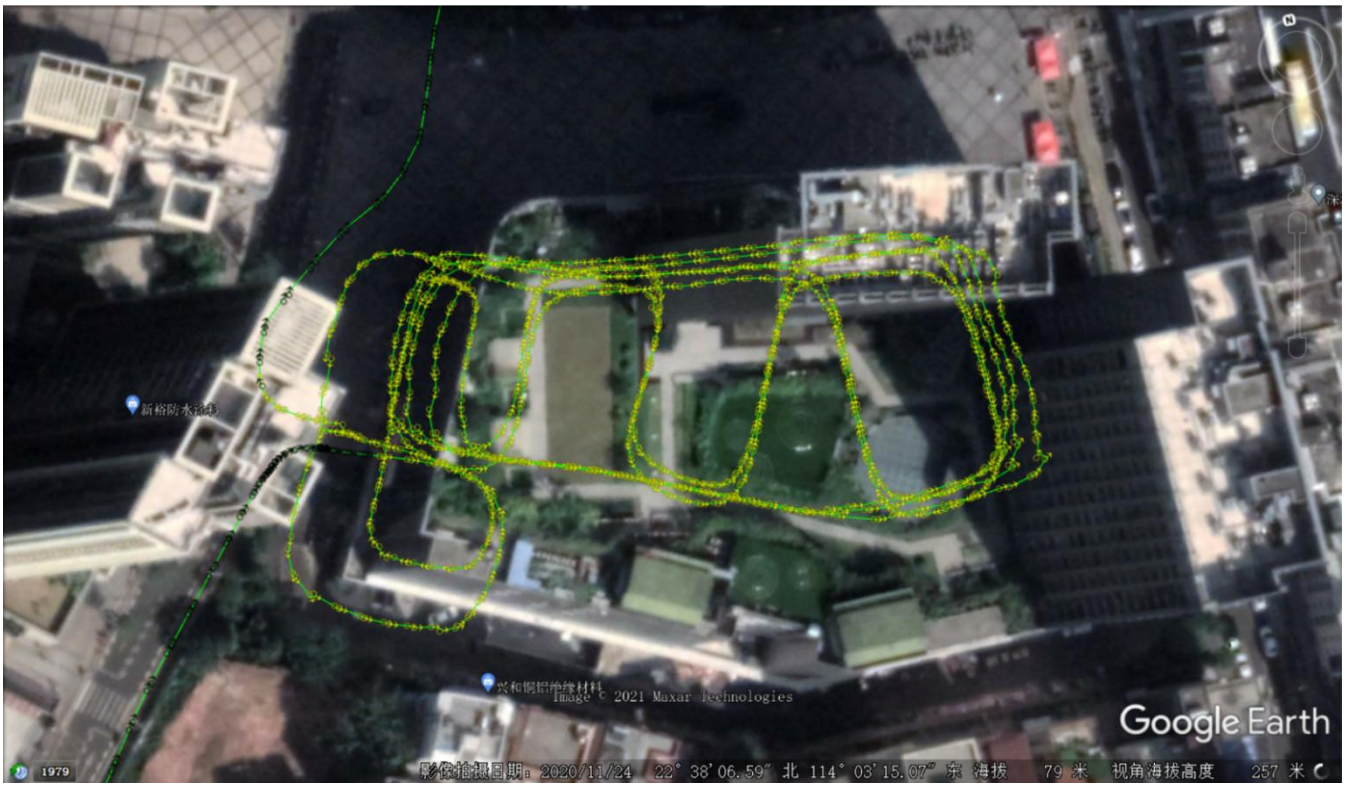
◆ **组合导航的定位性能/Positioning performance of integrated navigation**

人们使用高精度组合导航模块，希望可以在任何地方都可以获得非常精确的定位效果。

People use high-precision integrated navigation module, hoping to get very precise positioning effect anywhere.

惯性导航虽然不受环境影响，但是惯性导航是一个随着时间误差不断累加的导航定位技术，目前，根据车库和隧道的定位效果来看，我们研发的惯性导航模块的定位精度为 1%-2%，即行走 100 米误差为 1-2 米。从全球来看，这样的纯惯性导航定位精度也是非常高的水平。

Although inertial navigation is not affected by the environment, inertial navigation is a navigation and positioning technology with the continuous accumulation of time errors. At present, according to the positioning effect of garage and tunnel, the positioning accuracy of the inertial navigation module developed by us is 1%-2%, that is, the error of walking 100 meters is 1-2 meters. From a global perspective, such a pure inertial navigation positioning accuracy is also very high.



深圳某地下车库/A garage somewhere in Shenzhen

横龙山隧道/Henglongshan Tunnel

◆ **组合导航的抗漂移性能/Anti-drift performance of integrated navigation**

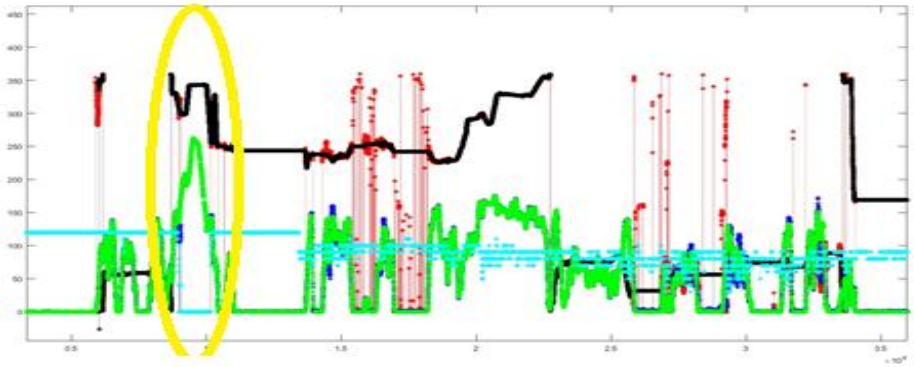
卫星导航在复杂环境下，车辆静止的时候，位置会漂移，增加惯性导航后，组合导航输出的定位信息完全可以抑制漂移，使得车辆定位的效果更加理想。

In the complex environment, the position of the vehicle will drift when the vehicle is stationary. After adding the inertial navigation, the positioning information output by the integrated navigation can completely suppress the drift, making the vehicle positioning effect more ideal.

◆ **组合导航的速度方向精度/Speed direction accuracy of integrated navigation**

组合导航系统除了提供高精度的定位信息之外，还提供了比卫星导航更加精确的速度和方向信息，尤其是在车库或者隧道等情况下。

In addition to providing high-precision positioning information, integrated navigation systems also provide more accurate speed and direction information than satellite navigation, especially in situations such as garages or tunnels.

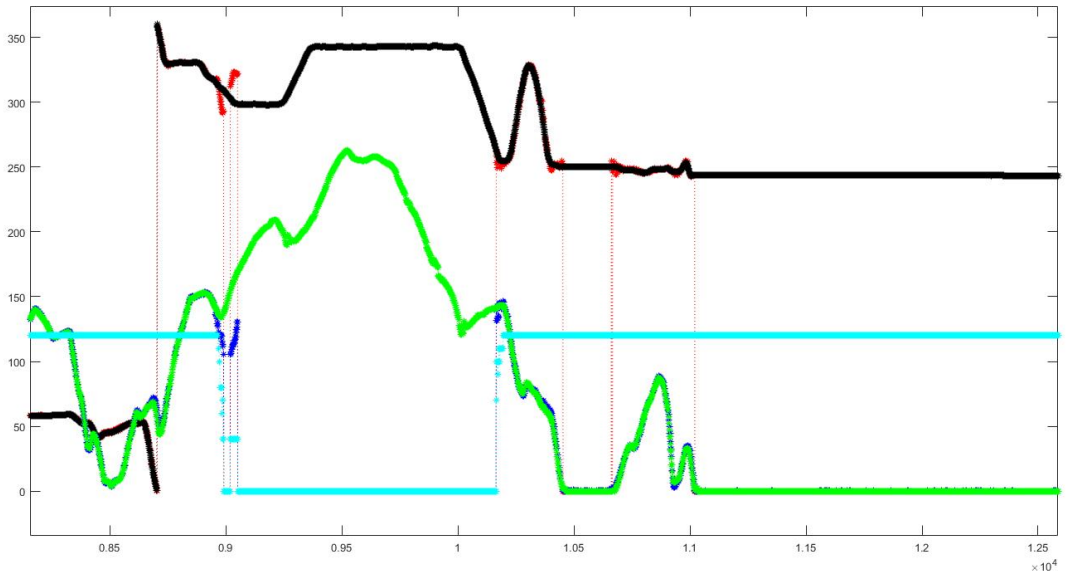


图中：红色为 GPS 提供的方向信息，黑色为组合导航提供的方向，蓝色为卫星提供的速度十倍放大，绿色为组合导航提供的速度信息十倍放大，青色为卫星提供的卫星数十倍放大。可以看出，在车辆低速的过程中，卫星导航提供的方向误差很大，当车辆静止的时候，没有方向信息。

In the picture: red is the direction information provided by GPS, black is the direction provided by integrated navigation, blue is the speed amplification provided by satellite, green is the speed amplification provided by integrated navigation, and cyan is the speed amplification provided by satellite. It can be seen that in the process of vehicle low speed, the direction error provided by satellite navigation is very large. When the vehicle is stationary, there is no direction information.

上图过程中，黄色区域为隧道过程的信息，放大之后，如下图所示：

In the process of the above figure, the yellow area is the information of the tunnel process. After zooming in, it is shown as the figure below:



通过上图可以看出，在隧道过程中，惯性导航提供了非常高精度的速度和方向信息，再此基础上，才可以获得高精度的位置信息。

As can be seen from the figure above, during the tunnel process, inertial navigation provides very high precision speed and direction information, and then can obtain high precision position information.

6 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		1.4	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.

7 性能指标/Performance evaluation

◆ **电气特性一倍标准差（1σ）无里程计时/Electrical characteristics one standard deviation (1σ) no mileage timing**

GNSS 信号丢失时间/Time of GNSS signal loss	接收机定位方式/Receiver positioning mode	水平位置[1]/Horizontal position 1	水平速度[1]/Horizontal velocity 1	俯仰横滚[1]/Pitch roll Angle 1	航向角[1]/Course Angle 1
5 秒/5 seconds	标准定位/Standard setting	2.0-3.5m	0.05m/s	0.5deg	1.0deg
10 秒/10 seconds	标准定位/Standard setting	10.0m	N/A	N/A	N/A

60 秒/60 seconds	标准定位/Standard setting	25.0m	N/A	N/A	N/A
120 秒/120 seconds	标准定位/Standard setting	60.0m	0.5m/s	1.0deg	2.0deg

◆ 电气特性一倍标准差（1σ）GNSS 部分功能/Electrical characteristics one standard deviation (1σ) 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 B1I
	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

8 管脚定义/PIN Definition

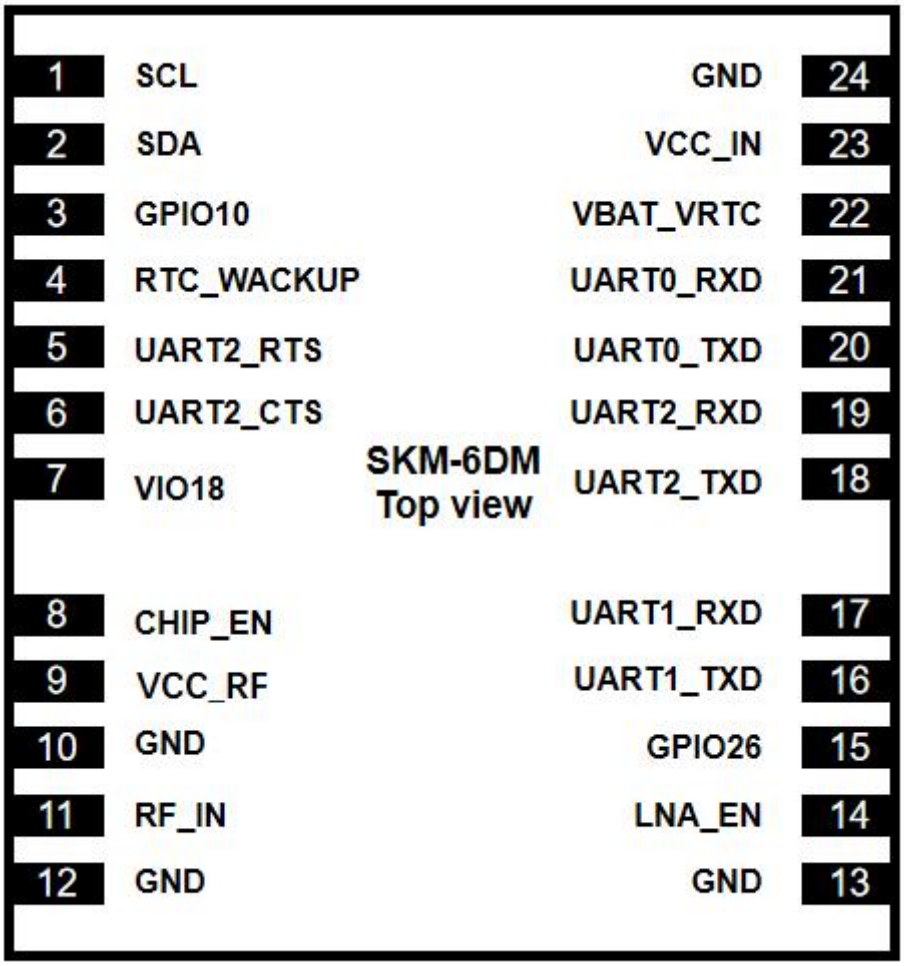


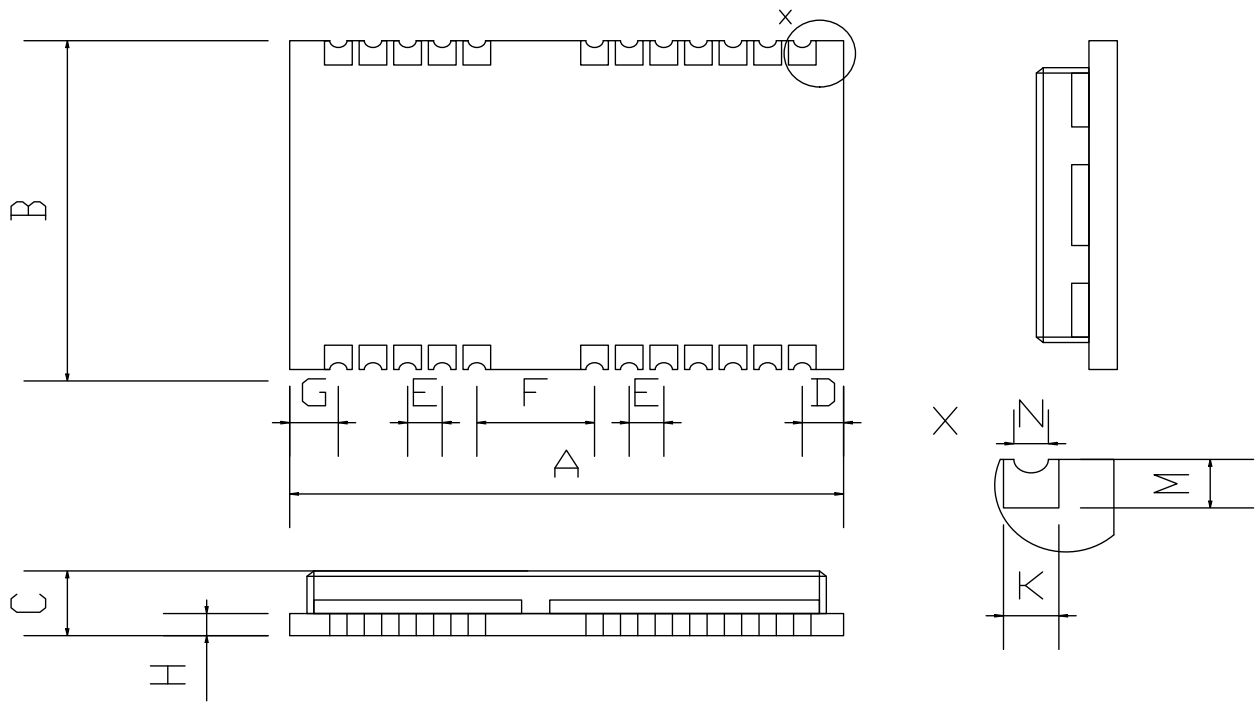
图 3：SKM-6DM 管脚定义/pin definitions

9 管脚描述/Pin description

管脚编号/Pin No.	管脚定义/Pin name	I/O	使用说明/Description	备注/Remark
1	SCL		悬空/Hanger	

2	SDA		悬空/Hanger	
3	GPIO10	O	秒脉冲信号输出/Second pulse signal output	
4	RTC_WACKUP	I	中断脚，低电平使能模块进入休眠状态/Interrupt pin. Low level enables the	
5	UART2_RTS		悬空/Hanger	
6	UART2_CTS	I	测试引脚，悬空/Test pin, hanger	悬空/Hanger
7	VIO18	0	测试引脚，悬空/Test pin, hanger	悬空/Hanger
8	CHIP_EN		模块复位，低电平有效/Module reset, active low	不用时，悬空/When not in use, hanger
9	VCC_RF	Pout	有源天线供电端输出/Active antenna power output	
10	GND	G	电源地/Ground	
11	RF_IN	I	GNSS 天线接口	
12	GND	G	电源地/Ground	
13	GND	G	电源地/Ground	
14	LNA_EN		悬空/Hanger	
15	GPIO26		接电源地	
16	UART1_TXD		必须悬空/Must be hung up	
17	UART1_RXD		必须悬空/Must be hung up	
18	UART2_TXD	O	备用串口发送/Standby serial port transmission	备用/Standby application
19	UART2_RXD	I	备用串口接收/Standby serial port reception	备用/Standby application
20	UART0_TXD	O	串口发送/Serial port to send	
21	UART0_RXD	I	串口接收/Serial port to receive	
22	VBAT_VRTC		备份电池/Backup battery：1.4V--3.6V	不用时，悬空/When
23	VCC_IN	Pin	工作电压/Operating voltage：3.0-3.6V	
24	GND	G	电源地/Ground	

10 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		0.82	
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：SKM-6DM 机械尺寸/Machine Dimension

11 参考电路/Reference circuit

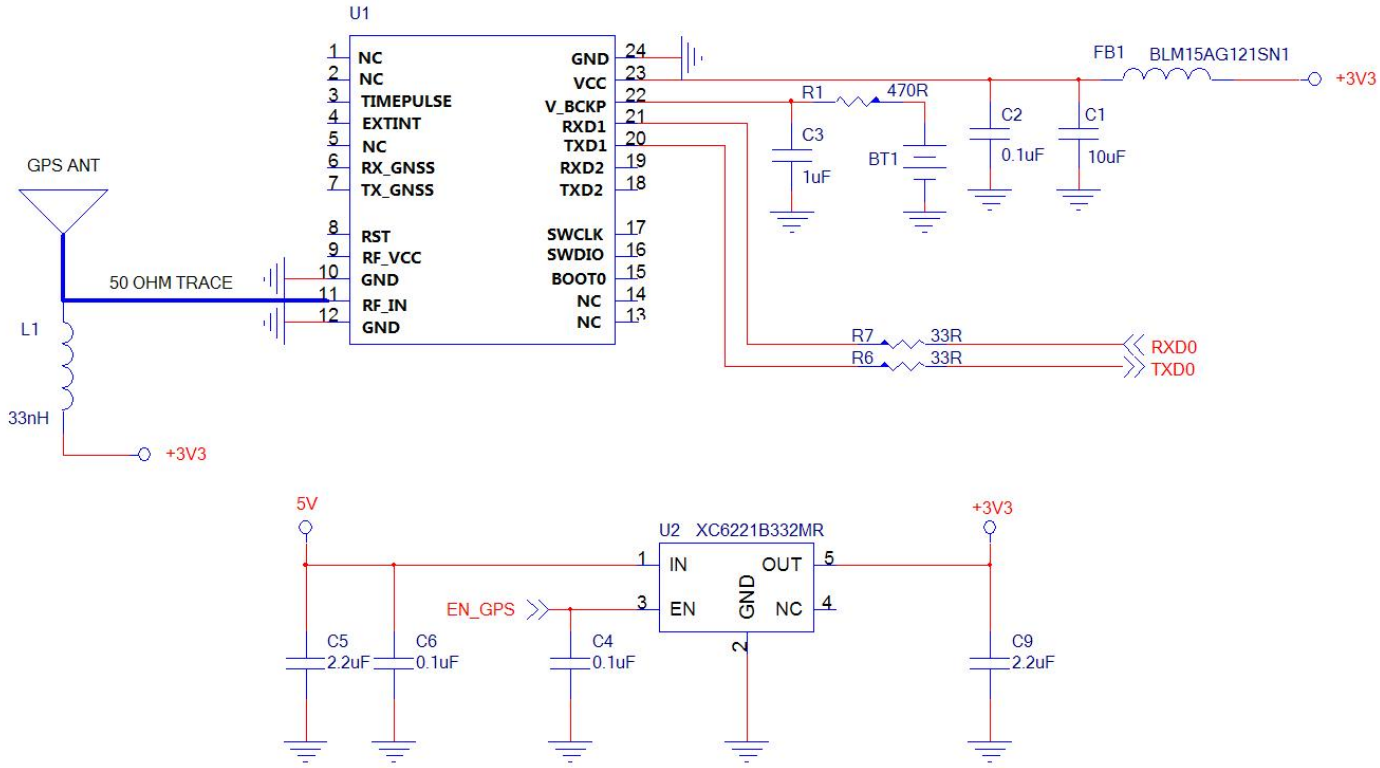


图 5：SKM-6DM 参考电路//Reference circuit

12 导航说明/Navigation instructions

◆ 模块无安装角度限制，自由安装，具备自适应功能/The module has no installation Angle limit, free installation, with adaptive function

◆ 组合导航初始化/Composite navigation initialization

目前，GI-200 惯性导航算法实现自适应安装算法，即用户可以任意安装模块，实现相同的组合导航效果。

At present, the GI-200 inertial navigation algorithm realizes the adaptive installation algorithm, that is, users can install any module to achieve the same combined navigation effect.

具体而言：用户需要把 SKM-6DM 和车体固定连接，静止上电，然后，车辆行驶起来，通过车辆的加速减速拐弯等车辆运动，SKM-6DM 识别出安装角度；总之，需要跑车一段时间，才可以获得安装角。

Specifically: the user needs to skM-6DM and car body fixed connection, static power, and then, the vehicle running, through the vehicle acceleration deceleration turning and other vehicle movement, SKM-6DM identify the installation Angle; In short, it takes a while for the sports car to get the mounting Angle.

当获得安装角之后，SKM-6DM 马上进入组合导航状态，再经过大约 1 分钟左右车辆行驶，，惯性导航训练成功，此时，可以进入隧道和车库等无卫星定位的区域。

When the installation Angle is obtained, SKM-6DM immediately enters the integrated navigation state, and after about one minute of vehicle running, the inertial navigation training is successful. At this time, skM-6DM can enter the tunnel, garage and other areas without satellite positioning.

具体初始化过程如下表所示/The following table describes the initialization process：

阶段 /stage	组合导航初始化过程/ Composite navigation initialization process	系统状态/ System state	定位结果 /Positioning results
1	上电后，静止 5-10 秒以上，完成导航系统的姿态初始化； 由于 SKM-6DM 具有自动识别车辆静止或动态的功能，如果车辆行驶过程中上电，在 SKM-6DM 会等到车辆静止后完成功能。 After the system is powered on, hold for more than 5-10 seconds to complete the attitude initialization of the navigation system. Since THE SKM-6DM has the function of automatically recognizing a stationary or dynamic vehicle, if the vehicle is powered on during the driving process, the SKM-6DM will wait until the vehicle is stationary to complete the function.	**GPATT 协议的 State_Flag 成为 01，GPGGA 的 InsTime 为 0** **The State Flag of GPATT becomes 01,The InsTime of GPGGA is 0**	输出纯卫星定位结果 /Output pure satellite positioning results
2	卫星定位成功，收到有效的卫星解析，并确保卫星定位达到一定精度（GPGGA 协议 Gps_Precision 小于 10），SKM-6DM 完成惯性导航位置初始化，GPATT 状态位变为 2。即卫星定位精度很差时，SKM-6DM 不对惯性导航位置进行初始化，而是输出卫星定位结果。 The satellite positioning is successful, the effective satellite resolution is received, and the satellite positioning accuracy is ensured (GPGGA protocol Gps_Precision is less than 10). The SKM-6DM completes the inertial navigation position initialization, and the GPATT status bit changes to 2. That is,	**GPATT 协议的 State_Flag 成为 02 GPGGA 的 InsTime 为 0** **The State Flag of GPATT becomes 02,The InsTime of GPGGA is 0**	输出纯卫星定位结果 /Output pure satellite positioning results

	when the satellite positioning accuracy is very poor, SKM-6DM does not initialize the inertial navigation position, but outputs the satellite positioning results.		
3	尽量保持 GI-200 导航系统在空旷的地方行驶一定时间，这个过程中，SKM-6DM 进行安装角识别，此过程中，SKM-6DM 完全复制卫星定位结果。获得安装角之后，GPATT 状态位为 2。Try to keep the GI-200 navigation system running in an open area for a certain period of time. During this process, SKM-6DM performs installation Angle identification, during which SKM-6DM completely duplicates the satellite positioning results. After obtaining the installation Angle, the GPATT status bit is 2.	**GPATT 协议的 State_Flag 变成 02 GPGGA 的 InsTime 为 0 The State Flag of GPATT becomes 02,The InsTime of GPGGA is 0**	输出纯卫星定位结果 /Output pure satellite positioning results
4	获得安装角之后，车辆行驶速度超过 3 米/秒，SKM-6DM 完成对惯性导航的速度和方向初始化，则 GPATT 状态位变为 3。After the installation Angle is obtained, the vehicle speed exceeds 3m/s, skM-6DM completes the initialization of the speed and direction of inertial navigation, and the GPATT status bit changes to 3.	**GPATT 协议的 State_Flag 变成 03， GPGGA 的 InsTime 为开始每秒加 1。 The State Flag of GPATT becomes 03,The InsTime of GPGGA start to increases by 1 per second.**	输出组合导航定位结果 /The integrated navigation location result is displayed
5	继续保持 GI-200 导航系统在空旷的地方行驶，这个过程中，SKM-6DM 利用卫星定位数据对惯性导航进行训练，此次，GPGGA 的 InsTime 每秒加 1，通过大约 1 分钟，即 InsTime 大于 60 之后，SKM-6DM 基本实现组合导航系统的算法收敛，即完成对惯性导航元件误差的估计。 The SKM-6DM continued to keep the GI-200 navigation system driving in the open area. During this process, the SKM-6DM used the satellite positioning data to train the inertial navigation system. This time, the GPGGA InsTime	**GPATT 协议的 State_Flag 成为 03， GPGGA 的 InsTime 每秒加 1。 The State Flag of GPATT becomes 03,The InsTime of GPGGA increases**	输出组合导航定位结果 /The integrated navigation location result is displayed

	increased by 1 per second, which passed about 1 minute after the InsTime was greater than 60. Skm-6dm basically realizes the algorithm convergence of integrated navigation system, that is, completes the estimation of inertial navigation element error.	**by 1 per second.**	
6	SKM-6DM 完成组合导航算法收敛后，可以进入隧道或车库等无卫星定位环境进行定位。 After the convergence of the integrated navigation algorithm is completed, SKM-6DM can enter the tunnel or garage for positioning without satellite.	**GPATT 协议的 State_Flag 为 03，GPGGA 的 InsTime 每秒加 1。 The State Flag of GPATT becomes 03,The InsTime of GPGGA increases by 1 per second.**	输出纯惯性导航定位结果/Output pure inertial navigation and positioning results
7	SKM-6DM 完成组合导航算法收敛后，可以进入高架下、高楼林立、小区等无卫星定位差的环境进行定位。 After SKM-6DM completes the convergence of the integrated navigation algorithm, it can enter the environment with no poor satellite positioning such as elevated buildings, residential areas and so on.	**GPATT 协议的 State_Flag 为 03，GPGGA 的 InsTime 每秒加 1。 The State Flag of GPATT becomes 03,The InsTime of GPGGA increases by 1 per second.**	输出组合导航定位结果/The integrated navigation location result is displayed
8	通过长时间的车辆行驶，SKM-6DM 对安装角进行了多次求解并且处理之后，获得更加精确的安装角。GPATT 状态位改为 4。 After a long time of vehicle driving, SKM-6DM solved and processed the mounting Angle for many times to obtain a more accurate mounting Angle. The GPATT status bit was changed to 4.	**GPATT 协议的 State_Flag 为 04。 The State Flag of GPATT becomes 04.**	输出组合导航定位结果/The integrated navigation location result is displayed

总结/Summary：

（1）组合导航系统初始化过程，建议车辆首先在无遮挡的环境下行驶大约几分钟，然后再进入有遮挡等复杂环境下，组合导航系统的定位效果才会好。

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

（2）其实，用户不需要特别关心 SKM-6DM 的初始化过程，只需要在空旷环境下行驶大约几分钟，就实现了惯性导航初始化。

(2) In fact, users do not need to pay special attention to the initialization process of SKM-6DM. They only need to drive in an open environment for a few minutes to realize the initialization of inertial navigation.

◆ 组合导航复位/Combined navigation reset

为了确保 SKM-6DM 可以长期高可靠性的提供稳定的车辆定位效果，与市场上常见的其他惯性导航模块一样，SKM-6DM 也具有自我失效检查功能，一旦确认当前的组合导航定位结果存在问题，SKM-6DM 马上进行组合导航复位，即从新进入组合导航初始化过程的第 4 阶段，即重新利用卫星导航结果对惯性导航进行位置、速度和方向的初始化。

In order to ensure that SKM-6DM can provide stable vehicle positioning effect with long-term high reliability, like other inertial navigation modules common in the market, SKM-6DM also has self-failure check function. Once it is confirmed that there is a problem with the current integrated navigation positioning result, SKM-6DM will immediately conduct integrated navigation reset. It is the fourth stage of the initialization process of integrated navigation, that is, the position, velocity and direction of inertial navigation are initialized by re-using the results of satellite navigation.

当然，SKM-6DM 发生组合导航复位的概率非常低，但是，为了提高可靠性，确实需要具有组合导航复位的功能。

Of course, SKM-6DM has a very low probability of combined navigation reset, but in order to improve reliability, it is necessary to have integrated navigation reset function.

13 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 SKM-6DM 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 SKM-6DM 达到相同的性能指标，出厂前已经对 SKM-6DM 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 SKM-6DM sensor components (three-axis gyroscope, three-axis accelerometer) zero, sensitivity and temperature drift parameters are not the same, in order to make each SKM-6DM to achieve the same performance indicators, the SKM-6DM sensor components have been a variety of error compensation.

每个产品的传感器组件标定参数均不一样，如果采用相同的参数，将会造成较大的导航误差，这种唯一性可用于防止了系统盗版，从而提高了用户产品的可靠性。

The calibration parameters of sensor components of each product are different. If the same parameters are used, large navigation errors will be caused. This uniqueness can be used to prevent system piracy and improve the reliability of user products.

◆ **通信接口/Communication interface**

SKM-6DM 模块提供了两个串口，其中，串口 0 用于发送卫星信息和接收差分信息，串口 2 用于输入、输出差分信息。

The SKM-6DM 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 SKM-6DM 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.

◆ **通信协议/Communication protocol**

目前，SKM-6DM 模块输出常见的 NMEA0183 协议，例如：GPGGA、GPRMC，GPGSV, GPGSA，另外，为了输出汽车姿态信息，SKM-6DM 模块定义了一组通信协议 GPATT。

At present, THE SKM-6DM module outputs common NMEA0183 protocols, such as GPGGA, GPRMC, GPGSV and GPGSA. In addition, in order to output vehicle attitude information, the SKM-6DM module defines a group of communication protocols GPATT.

◆ **控制命令/Control command**

SKM-6DM 系统支持用户通过串口发控制命令实现如下功能，但是，SKM-6DM 无法保存设置，即 SKM-6DM 每次上电都是按默认方式输出。

The SKM-6DM system supports the following functions by sending control commands through the serial port. However, the SKM-6DM cannot save the Settings. That is, the SKM-6DM output the default mode every time it is powered on.

表 1 惯性导航 NEMA 使能/Inertial navigation NEMA

类型/ Type	类型属性/Type attribute	通信协议/ Communication protocol	默认值/ Default	备注/ Remark
1	log gpgsv	打开 NEMA 语句/Open the NEMA statement	默认/Default	
2	unlog gpgsv	关闭 NEMA 语句/Close the NEMA statement		

表 2 惯性导航 IMU 使能

类型/ Type	类型属性/Type attribute	通信协议/ Communication protocol	默认值/ Default	备注/ Remark
1	log debug	打开 IMU 输出语句/Open the IMU output statement	默认/Default	可以查看导航数据/You can view the navigation data

14 注意事项/Matters need attention

SKM-6DM 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, SKM-6DM module also requires users to pay attention to some matters during use, as shown in the following table:

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.	必须/Must

	There is no specific installation Angle requirement and it is self-adaptive.	
2	上电前，固定连接车体和 SKM-6DM，模块无摇晃； Before the device is powered on, the car body is fixedly connected to SKM-6DM, and the module does not shake;	必须/Must
3	上电后，不能再移动 SKM-6DM； After the device is powered on, the SKM-6DM 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

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 2 分钟后，在直线的道路上有加减速操作，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	行驶 5-10 分钟后进入复杂环境（如车库、隧道） Enter complex environment (e.g. garage, tunnel) after 5-10 minutes of driving	必须/Must
4	再次上电后，可以省略直线加减速识别安装角的步骤，（见表序号 2） 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.

◆ **卫星定位精度/GPS_Precision**

SKM-6DM 是一个组合导航定位模块，而用户获得定位结果是由天线+SKM-6DM 模块+用户终端共同实现的结果。只有卫星定位实现正常的定位的前提下，SKM-6DM 才可以实现较好的组合导航定位效果。在实际使用过程中，由于用户天线或者底板供电等各个方面因素，会造成 SKM-6DM 模块的卫星定位效果不稳定甚至无法定位，从而使得 SKM-6DM 整体的定位效果很差。

SKM-6DM is a combined navigation and positioning module, and the user can obtain the positioning result by antenna +SKM-6DM module + user terminal. Skm-6dm can achieve good integrated navigation and positioning effect only when the satellite positioning can achieve normal positioning. In actual use, due to various factors such as user antenna or power supply from bottom plate, the satellite positioning effect of SKM-6DM module will be unstable or even unable to be positioned, thus making the overall positioning effect of SKM-6DM very poor.

GPS_Precision 是 SKM-6DM 提供的以米为单位的卫星定位精度，例如，SKM-6DM 在空旷环境下，卫星定位精度 GPS _Precision 一般在 0.4 米左右。

GPS_Precision is the satellite positioning precision in meters provided by SKM-6DM. For example, IN open environment of SKM-6DM, GPS_Precision of satellite positioning accuracy is generally about 0.4 meters.

强烈建议用户通过通信把 GPS_Precision 上传到服务器，一旦 SKM-6DM 定位出现问题，可以基于 GPS _Precision 数值绘制成曲线，便于分析造成问题的原因，便于产品维护。否则，SKM-6DM 产品出现问题，用户很难分析具体原因。

It is strongly recommended that users upload GPS_Precision to the server through communication. Once problems occur in SKM-6DM location, a curve can be drawn based on GPS-_precision value, which is convenient to analyze the cause of the problem and facilitate product maintenance. Otherwise, it is difficult for users to analyze the specific cause of problems in SKM-6DM products.

GPS _Precision 放置在 GNGGA 协议的第 9 个字段。

GPS Precision is placed in the ninth field of the GNGGA protocol.

◆ **惯性导航训练时间/Ins Time**

SKM-6DM 是一个组合导航定位模块，组合导航系统需要通过卫星导航求解惯性导航的各种误差，所以，必须有一个训练过程，即用高质量的卫星导航来训练惯性导航的性能，使得惯性导航可以估计出自身的误差，如果训练时间很短，则无法实现很好的性能。

SKM-6DM is a integrated navigation positioning module, integrated navigation system need by various error of inertial navigation, satellite navigation solution, therefore, must have a training process, which USES the high quality of the performance of the inertial navigation satellite navigation to training, make the error of inertial navigation can estimate the oneself, if the training time is very short, can achieve good performance.

Ins Time 是 SKM-6DM 提供的以秒为单位的组合导航训练时间，建议 SKM-6DM 进入隧道和车库等无卫星定位的区域，应该保证 Ins Time 是大约等于 60，当然，Ins Time 越大越好，代表 SKM-6DM 通过卫星定位训练惯性导航时间越长。

Ins Time is the combined navigation training Time provided by SKM-6DM in seconds. It is recommended that SKM-6DM enter areas without satellite positioning such as tunnels and garages, and ensure that Ins Time is approximately equal to 60. Of course, the larger Ins Time is, the better. It means the longer it takes skM-6DM to train inertial navigation through satellite positioning.

强烈建议用户通过通信把 Ins Time 上传到服务器，一旦 SKM-6DM 在复杂环境下，例如车库或者隧道无法实现定位，可以通过分析 Ins Time 的数值，确定 SKM-6DM 当前处于什么状态。

It is strongly recommended that users upload Ins Time to the server through communication. Once SKM-6DM cannot locate in complex environment, such as garage or tunnel, it can determine the current state of SKM-6DM by analyzing the value of Ins Time.

◆ **卫星定位原始数据/GIRMC**

SKM-6DM 是一个组合导航定位模块，定位结果是由卫星定位和惯性定位共同实现，为了让用户了解 SKM-6DM 卫星定位的效果，SKM-6DM 默认输出 GIRMC 协议，该协议的帧头为 GIRMC，协议内容完全复制 SKM-6DM 内部主芯片输出的 GNRMC 协议内容。

SKM-6DM is a combined navigation and positioning module, and the positioning result is realized by satellite positioning and inertial positioning. In order to let users know the effect of SKM-6DM satellite positioning, SKM-6DM output GIRMC protocol by default, and the frame header of this protocol is GIRMC. The protocol content is exactly the GNRMC protocol content output by the main chip in SKM-6DM.

用户可以通过对比 GNRMC 和 GIRMC 定位结果，确认组合导航定位的效果。

You can compare the GNRMC and GIRMC positioning results to confirm the combined navigation positioning effect.

◆ **惯性导航提供的静止标志位/Stationary flag bits provided by inertial navigation**

传统的定位模块在车辆静止的时候，也会有位置和速度飘逸，致使用户很难判断车辆是否静止。SKM-6DM 是一个组合导航定位模块，可以根据惯性元件的状态进行车辆静止或动态判断，对于基于车辆里程收费的用户，该标志为非常有帮助，即根据该标志可以判断车辆是否在运动，在运动状态下，累加车辆行驶的轨迹获得精确的里程信息。

When the vehicle is stationary, the traditional positioning module will also have an elegant position and speed, which makes it difficult for users to judge whether the vehicle is stationary or not. SKM-6DM is a integrated navigation positioning module, can according to the state of inertial components, and the vehicle static or dynamic judgment, for users based on vehicle travel fees, the flag is very helpful, namely according to the sign can be judged whether the vehicle in motion, the motion state, the accumulative vehicle trajectory to obtain accurate mileage information.

15 语句解析/Statement parsing

15.1 GNGGA

例如：$GNGGA,062938.00,3110.4700719,N,12123.2657056,E,1,12,0.6,58.9666,M,0.000,M,99,0000*50

编号/No.	名称/Name	描述/Description	符号/Symbol	举例/Example
1	$GPGGA	Log header		$GPGGA
2	utc	UTC时间 (时/分/秒)/ UTC time (H/M/S)	hhmmss.ss	202134.00
3	lat	纬度/Latitude：-90°~90°	llll.lllllll	3110.4693903
4	latdir	纬度方向：N：北；S：南 Latitude direction: N: north; S: the south	a	N
5	lon	经度/Longitude：-180°~180°	yyyyy.yyyyyyy	12123.2621695
6	londir	经度方向：E：东；W：西 Longitude direction: E: east; W: west	b	W
7	**QF**	**解状态/ Solution state 0：无效解/Solution trivial； 1：单点定位解/Single point**	**q**	**1**

		positioning solution； 2：伪距差分/gpspseudorang differential gps； 6:纯惯导解 /Pure inertial navigation solution		
8	sat No.	卫星数/Satellite data	n	14
9	**Gps_Precision**	**卫星定位精度/Satellite positioning accuracy**	**x.x**	**0.6**
10	alt	高程/Altitude	h.h	50.22
11	a-units	高程单位/Altitude units	M	M
12	Geoidal	大地水准面/Geoidal surface	xxx.x	0.000
13	a-units	单位/Units	M	M
14	age	差分延迟/Differential delay	dd	1
15	**InsTime**	**组合导航训练时间/ Combined navigation training time**	**xxxx**	**1**
16	*xx	Checksum	*hh	
17	[CR][LF]	Sentence terminator		[CR][LF]

说明：SKM-6DM 修改了 GGA 官方协议的三个字段。

Note: SKM-6DM modifies three fields of GGA official protocol.

（1）字段第 7 ：增加了解状态 6，在没有卫星信号的场所，例如地下车库、隧道，模块进入纯惯导解状态，标志位变成 6

(1) Field 7; Add Solution state 6. In places where there is no satellite signal, such as underground garage and tunnel, the module enters the pure inertial navigation solution state, and the flag bit becomes 6

（2）第 9 字段：HDop 修改为 Gps_Precision/ Field 9: HDop changed to Gps_Precision

Gps_Precision 是 GI200 提供的以米为单位的卫星定位精度，例如，GI200 在空旷环境下，卫星定位精度 Gps_Precision 一般在 0.4 米左右。强烈建议用户把 Gps_Precision 利用起来，可以便于产品维护。

Gps_Precision is the satellite positioning accuracy provided by GI200 in meters. For example, in the open environment of GI200, the satellite positioning accuracy Gps_Precision is generally about 0.4 meters. It is highly recommended that you take advantage of Gps_Precision to facilitate product maintenance.

（3）第 15 字段：StatteID 修改为 InsTime/ Field 15: StatteID is changed to InsTime

InsTime 是 GI200 提供的以秒为单位的组合导航训练时间，建议 GI200 进入隧道和车库等无卫星定位的区域，应该保证 InsTime 是大约等于 60，当然，InsTime 越大越好，代表 GI200 通过卫星定位训练惯性导航时间越长。InsTime is the combined navigation training time provided by GI200 in seconds. It is recommended that GI200 enter areas without satellite positioning, such as tunnels and garages. Ensure that the InsTime is about 60. Of course, the larger InsTime is, the better it is, which means the longer the inertial navigation time of GI200 through satellite positioning training.

15.2 GNRMC

例如：$GNRMC,064401.65,A,3110.4706987,N,12123.2653375,E,0.604,243.2,300713,0.0,W,A*3E

编号/No.	名称/Name	描述/Description	符号/Symbol	举例/Example
1	$GPRMC	Log header		$GPRMC
2	utc	UTC时间（时/分/秒）/ UTC time (H/M/S)	hhmmss.ss	143550.00
3	Pos status	解状态/Solution state A=有效定位/Effective positioning V=无效定位/Invalid location	A	A
4	lat	纬度/Latitude：-90°~90°	llll.lllllll	3110.4854911
5	latdir	纬度方向：N：北；S：南 Latitude direction: N: north; S: the south	a	N
6	lon	经度/Longitude：-180°~180°	yyyyy.yyyyyyy	12123.9129278
7	londir	经度方向：E：东；W：西 Longitude direction: E: east; W: west	b	E
8	SPEED IN	地面速率/Rate of ground	q	0.29
9	Track Ture	地面航向角/Ground heading Angle	n	108.5
10	Date	UTC日期/UTC date	ddmmyy	010909
11	Mag var	磁偏角（000.0~180.0度，前导位数不足则补0） Magnetic declivity (000.0°~180.0 °, if leading digit is lacking than 0 is added)	0.0	0.0
12	Vardir	磁偏角方向，E（东）或W（西） Direction of magnetic declination, E (east) or W (west)	M	M

13	Mode ind	模式指示（仅NMEA0183 3.00版本输出，A=自主定位，D=差分，E=估算，N=数据无效）Mode indication (NMEA0183 version 3.00 output only, A= autonomous positioning, D= difference, E= estimation, N= data invalid)	a	A
14	*xx	Checksum	*hh	*57
15	[CR][LF]	Sentence terminator		[CR][LF]

15.3 DEBUG

例如：$DEBUG,0,0,0,100.00,100.00,100.00*7E

编号/No.	名称/Name	描述/Description	符号/Symbol	举例/Example
1	$GIRMC	Log header		$GPRMC
2	utc	UTC时间（时/分/秒）/ UTC time (H/M/S)	hhmmss.ss	143550.00
3	Pos status	解状态/Solution state A=有效定位/Effective positioning V=无效定位/Invalid location	A	A
4	lat	纬度/Latitude：-90°~90°	llll.lllllll	3110.4854911
5	latdir	纬度方向：N：北；S：南 Latitude direction: N: north; S: the south	a	N
6	lon	经度/Longitude：-180°~180°	yyyyy.yyyyyyy	12123.9129278
7	londir	经度方向：E：东；W：西 Longitude direction: E: east; W: west	b	E
8	SPEED IN	地面速率/Rate of ground	q	0.29
9	Track Ture	地面航向角/Ground heading Angle	n	108.5
10	Date	UTC日期/UTC date	ddmmyy	010909
11	Mag var	磁偏角（000.0~180.0度，前导位数不足则补0）Magnetic declivity (000.0° ~180.0 °, if leading digit is	0.0	0.0

		lacking than 0 is added)		
12	Vardir	磁偏角方向，E（东）或W（西） Direction of magnetic declination, E (east) or W (west)	M	M
13	Mode ind	模式指示（仅NMEA0183 3.00版本输出，A=自主定位，D=差分，E=估算，N=数据无效） Mode indication (NMEA0183 version 3.00 output only, A= autonomous positioning, D= difference, E= estimation, N= data invalid)	a	A
14	*xx	Checksum	*hh	*57
15	[CR][LF]	Sentence terminator		[CR][LF]

提示：GIRMC 为卫星定位模块原始协议 GNRMC 修改帧头为 GIRMC 后的协议，用户使用时，需要把 GIRMC 重新替换为 GNRMC，然后才可通过校验。否则无法通过校验。

Note: GIRMC is the original protocol GNRMC of the satellite positioning module after the frame header is changed to GIRMC. If you use it, you need to replace GIRMC with GNRMC again and then you can pass the verification. Otherwise, the verification fails.

15.4 GPATT

例如：

$GPATT,0.035,p,-0.02,r,0.000,y,20180518,s,003E0038510D343439373239,ID,1,INS,401,02,0,0,G,AU,1,7,1,0,F,0,2*05

编号/No.	名称/Name	描述/Description	符号/Symbol	举例/Example
1	$GPATT	Log header		$GPATT
2	Pitch	俯仰角/Angle of pitch	ddd.mm	1.34
3	Angle Channel	P:俯仰,r:横滚,y:偏航/ P: pitch, R: roll, Y: yaw	P	P
4	Roll	横滚角/Roll angle	ddd.mm	2.56
5	Angle	P:俯仰,r:横滚,y:偏航/	A	R

	Channel	P: pitch, R: roll, Y: yaw		
6	Yaw	偏航角/Yaw angle	ddd.mm	132.45
7	Angle Channel	P:俯仰,r:横滚,y:偏航/ P: pitch, R: roll, Y: yaw		Y
8	Soft Version	软件版本号/Software Version	xxxxxxxx	20180518
9	Version Channel	S:软件版本号/ S:Software Version		S
10	Produtct ID	96位唯一ID/96-digit unique ID		003E0038510D343439373239
11	ID Channel	ID:产品ID/ ID: the product ID	ID	ID
12	INS	默认打开惯性导航/ Inertial navigation is turned on by default	X	1：打开，0：关闭/ 1: open, 0: closed
13	INS Channel	INS:惯性导航是否打开/ NS: Whether inertial navigation is on	INS	INS
14	硬件版本 /Hardware version	以主控芯片命名/Named after the main control chip	401	
15	State_Flag	算法状态标志/ Algorithm status flag	d	详情请见下表A/ See table A below for details
16	自定义标志 /Custom flags	自定义标志/Custom flags	X	X
17	自定义标志 /Custom flags	自定义标志/Custom flags	X	X
18	北斗标志 /Beidou flags	选择GPS+BD/GPS+Glonass	B	B:GPS+BD,G:GPS+Glonass
19	自定义标志 /Custom flags	自定义标志/Custom flags	AU	X
20	StaticFlag	静态标志位/Static flag bit	d	1：静止，0：代表动态/ 1: static, 0: dynamic
21	Uer_Code	用户编号/User number	d	1：普通用户，X：定制用户/ 1: common user, X: customized user

22	Angle_Select	是否采用flash安装角标志/ Whether to use the flash installation Angle mark	d	1：不采用存储安装角 2：采用存储安装角/ 1: do not use the storage installation Angle. 2: Use the storage installation Angle
23	Save_Gps_Flag	车库内保存卫星最后位置的标志/The last location of the satellite is kept in the garage	d	1：有车库位置记录成功 0：无记录/ 1: the garage location is recorded successfully. 0: No record is recorded
24	ALocK_Channel	安装角选择通道/Installation Angle selection channel	F	F
25	Angle_Lock_Flag	是否固定安装标志/Whether to fix the installation mark	d	1：启动固定安装， 0：启动自适应安装/ 1: starts fixed installation. 0: starts adaptive installation
26	IMU_Kind_Flag	安装坐标系/Installation coordinate system	d	1->8
28	总里程数/The total mileage	记录模块从开始定位到断电/Record the module from positioning to power-off 总里程数/The total mileage	km	最高记录：999.999km/ Record: 999.999km
29	*xx	Checksum	*hh	*57
30	[CR][LF]	Sentence terminator		[CR][LF]

表 A GPATT 协议 15 字段 State_Flag 各位物理含义说明

Table A Description of physical meanings of GPATT 15 field State_Flag

编号/No.	描述/Description	所需条件/Conditions
0	准备初始化/ Preparing for initialization	系统上电/System is powered on
1	姿态初始化完毕/ The attitude initialization is complete	车静止 5-10S/ The car still 5-10s
2	位置初始完毕/Position initial	获得位置/Get position

	complete	
3	安装角识别成功，进入组合导航/ Installation Angle identified successfully, enter the integrated navigation	车速超过 5m/s，行驶一段时间/ The vehicle speed exceeds 5m/s, driving for a period of time
4	安装角识别完毕/ Installation Angle has been identified	行驶一段时间/Drive for a while

备注：惯性导航能够正式工作的条件为：

Note : Inertial navigation can formally work under the following conditions:

(1) GPATT 协议 12 字段 INS 为 1/ The INS value of GPATT protocol 12 is 1。

(2) GPATT 协议 15 字段 State_Flag 为 03/04/ The State Flag of GPATT 15 is 03/04。

16 联系方式/ Contact Information

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