SKM2305NDR-40MXT 规格书

双频组合导航模块/

SKM2305NDR-40MXT Datasheet

Dual frequency integrated navigation module

系列型号/Serial model No.：SKM2305NDR-40M3T

SKM2305NDR-40M5T

SKM2305NDR-40M8T

文档信息/Document information		
标题/Title	SKM2305NDR-40MXT 双频组合导航模块规格书 SKM2305NDR-40MXT Dual frequency integrated navigation module	
文档类型/Document type	规格书/Datasheet	
文档编号/Document number	SL-22020219	
修订和日期/Revision and date	V1.05	14-Nov-2022
公开限制/Disclosure restriction	外部公开/External Public	

版本历史/Revision History

版本/Version	描述/Description	制定/Make	日期/Date
V1.01	初始版本	Wilson	20211224
V1.02	增加英文版/Add English version	Wendy	20220505
V1.03	更新接收机类型/Update the Receiver type	Wendy	20220810
V1.04	删除 GPATT 语句/Delete the GPATT statement	Wendy	20221114
V1.05	更新使用说明和语句解析/Update the usage instructions and statement parsing	Wendy	20221129

目录/Contents

1 产品简介/Product Introduction

SKM2305NDR-40MXT 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，SKM2305NDR-40MXT 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，SKM2305NDR-40MXT 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。

SKM2305NDR-40MXT 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 SKM2305NDR-40MXT 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, SKM2305NDR-40MXT 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：SKM2305NDR-40MXT 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

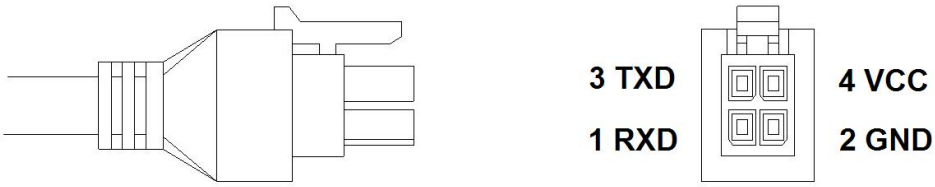
3 产品特点/Features

- 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 接口定义/Interface definition



RS232	TTL Level
1 RXD	1 RXD
2 GND	2 GND
3 TXD	3 TXD
4 VCC	4 VCC

Note:

RXD: Serial Data Input To SKM2305

TXD: Serial Data Output From SKM2305

图 2：SKM2305NDR-40MXT 接口定义/Interface definition

6 接口描述/Interface description

电源：SKM2305NDR 系列输入电压 VCC 范围为 3.5 V~ 5.5V，电流要求大于 100mA。靠近接口电源的地方请放置去耦电容（10uF 和 1uF）。

Power supply: SKM2305NDR series input voltage VCC range is 3.5V ~ 5.5V, current requirement is greater than 100mA.Place decoupling capacitors (10uF and 1uF) close to the interface power supply.

UART 端口：SKM2305NDR 系列支持一个完整的双工系列通道 UART。

UART port: The SKM2305NDR series supports a complete duplex series channel UART.

RS232 电平：SKM2305NDR 系列使用单芯片 RS232 到 UART bridge，它是 3.3V 驱动的 EIA / TIA-232 和 V.28/V.24。

RS232 level: The SKM2305NDR series uses a single-chip RS232 to UART bridge, which is 3.3V driven EIA/TIA-232 and V.28/V.24.

序号/NO.	名称/Name	输入/输出 Input/Output	描述/Describe	备注/Remark
Micro-Fit 3.0 连接头/ Micro-fit 3.0 connector				
1	RXD	I	UART Serial Data Input	RS232 电平
2	GND	G	Power Ground	Reference Ground
3	TXD	O	UART Serial Data Output	RS232 电平
4	VCC	P	Power Supply	VCC:3.5V~5.5V

7 设计原理/Design diagram

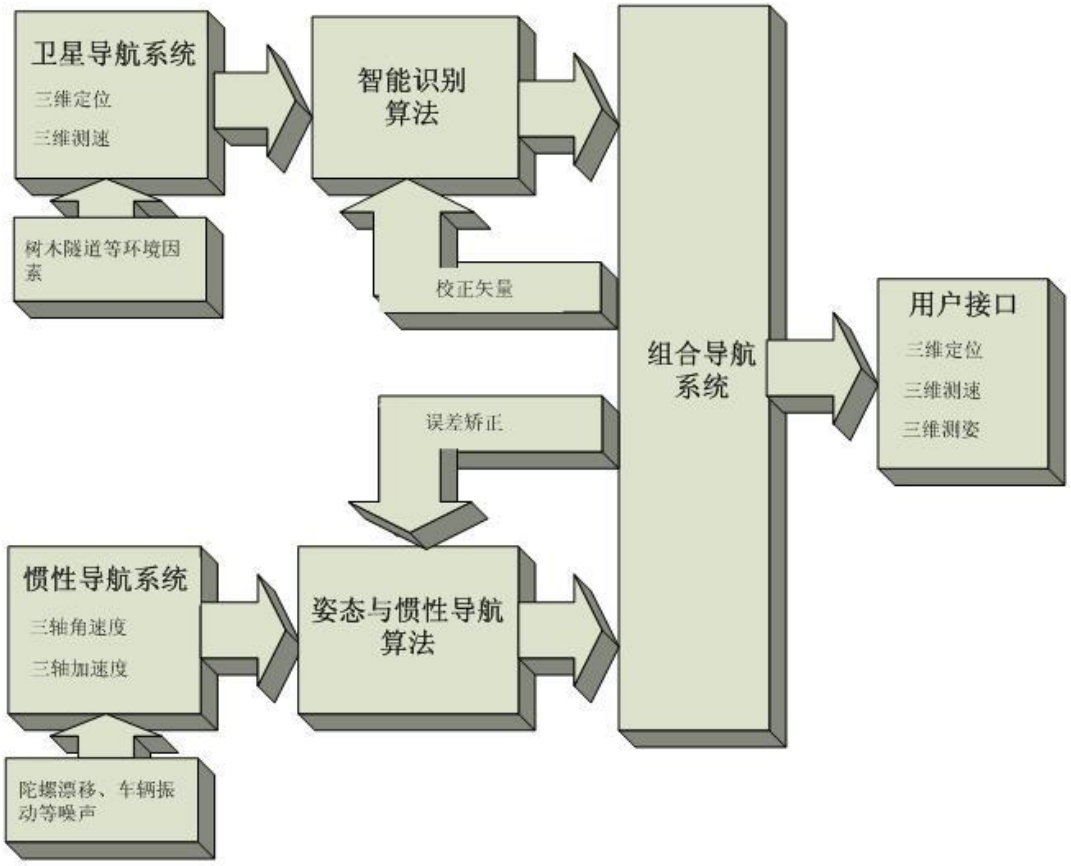


图 3：SKM2305NDR-40MXT 设计原理框图/Design diagram

7.1 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，SKM2305NDR-40MXT 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，SKM2305NDR-40MXT 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,SKM2305NDR-40MXT 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 SKM2305NDR-40MXT module can be connected to the odometer signal, which will achieve better performance indicators.

◆ 车辆姿态角/Vehicle attitude Angle：

SKM2305NDR-40MXT 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。

SKM2305NDR-40MXT 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：

SKM2305NDR-40MXT 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，SKM2305NDR-40MXT 导航模块实现了组合导航和纯惯性导航的自主切换。

SKM2305NDR-40MXT 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, SKM2305NDR-40MXT navigation module realizes the autonomous switch between integrated navigation and pure inertial navigation.

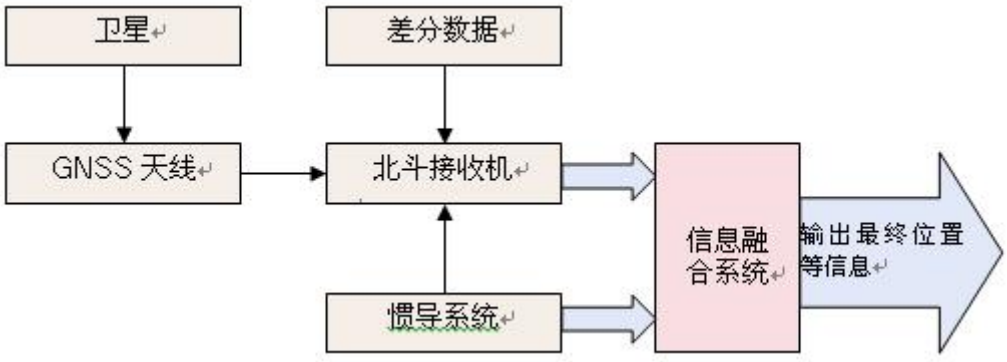
7.2 技术方案/Technical proposal

◆ 基于差分系统，获得 RTCM2.3-3.3 的差分数据，SKM2305NDR-40MXT 可实现差分定位，在空旷环境下可以实现亚米级的定位精度；

Based on the difference system, the difference data of RTCM2.3-3.3 can be obtained. SKM2305NDR-40MXT 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.



7.3 方案说明/Programme narratives

◆ **差分高精度/Differential precision**

SKM2305NDR-40MXT 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。

SKM2305NDR-40MXT 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.

7.4 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**

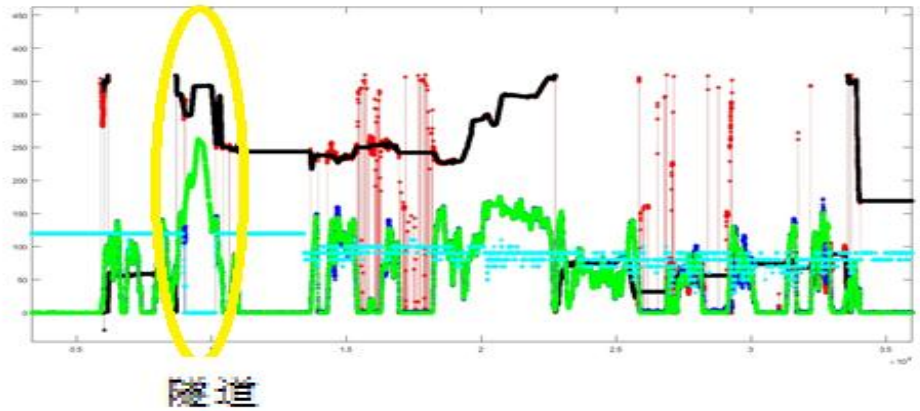
卫星导航在复杂环境下，车辆静止的时候，位置会漂移，增加惯性导航后，组合导航输出的定位信息完全可以抑制漂移，使得车辆定位的效果更加理想。

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.

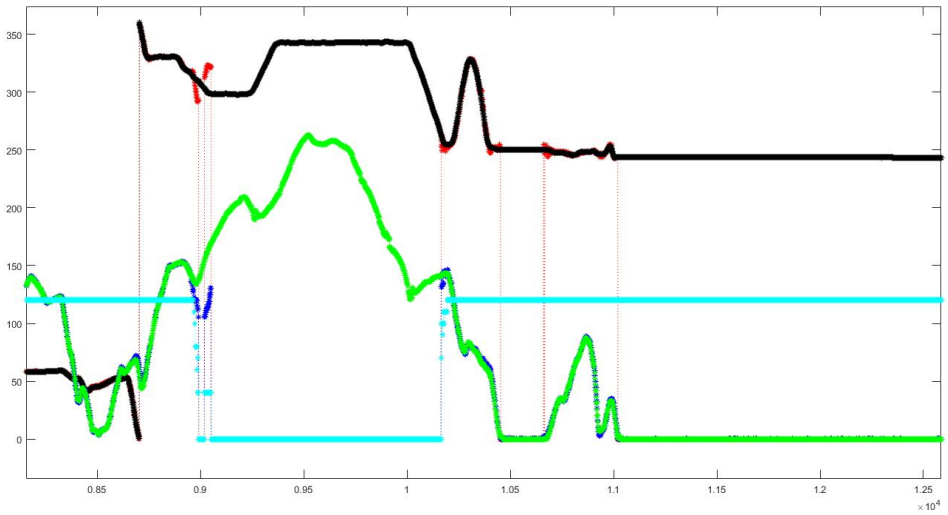


图中：红色为 GPS 提供的方向信息，黑色为组合导航提供的方向，蓝色为卫星提供的速度十倍放大，绿色为组合导航提供的速度信息十倍放大，青色为卫星提供的卫星数十倍放大。可以看出，在车辆低速的过程中，卫星导航提供的方向误差很大，当车辆静止的时候，没有方向信息。

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.

8 电气特性/Electrical characteristics

◆ **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	5.5	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	105	° 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		3.5	5	5.5	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

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.

9 性能指标/Performance evaluation

◆ **电器特性一倍标准差（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

◆ **电器特性一倍标准差（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		
	重捕获/Reacquisition：1s		
电源功耗/Power consumption	跟踪/Tracking：56~59mA @5V Typical		
	捕获/Acquisition：57~62mA @5V		
灵敏度/Sensitivity	跟踪/Tracking：-165dBm		
	捕获/Acquisition：-148dBm		
水平定位精度/Horizontal positioning precision	自主定位/Autonomous positioning：1.5m		
	SBAS：1m		
授时精度/Timing precision	RMS：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		

10 模块尺寸/Module size

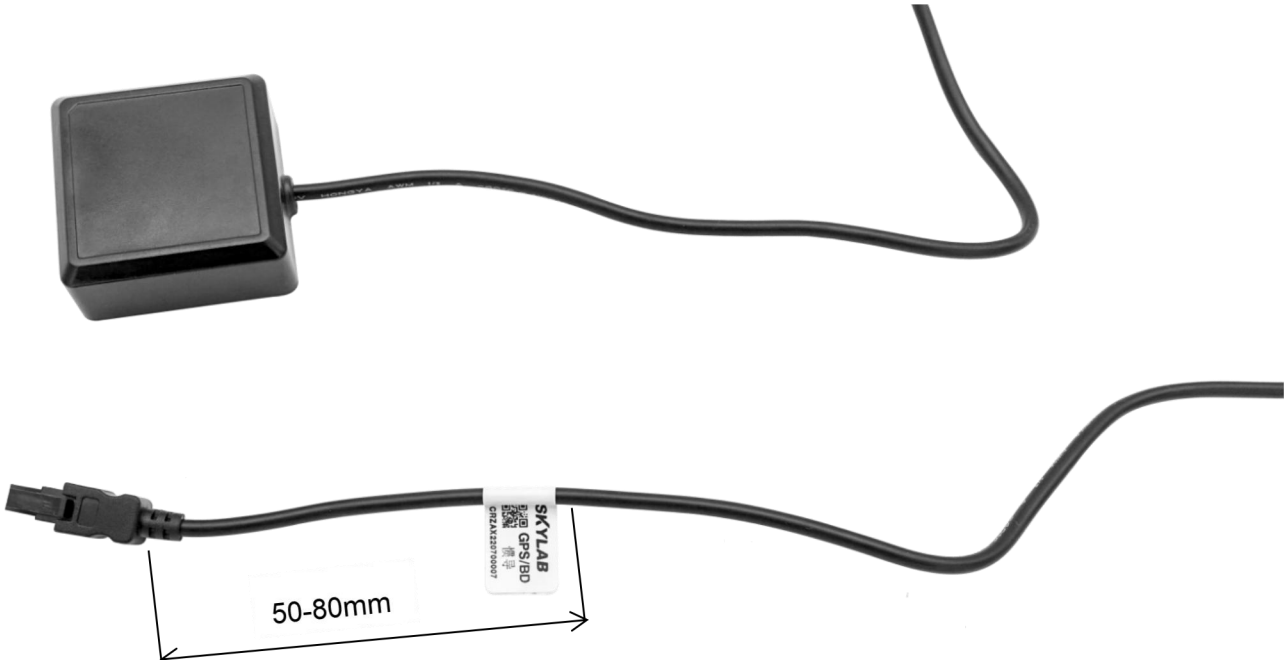
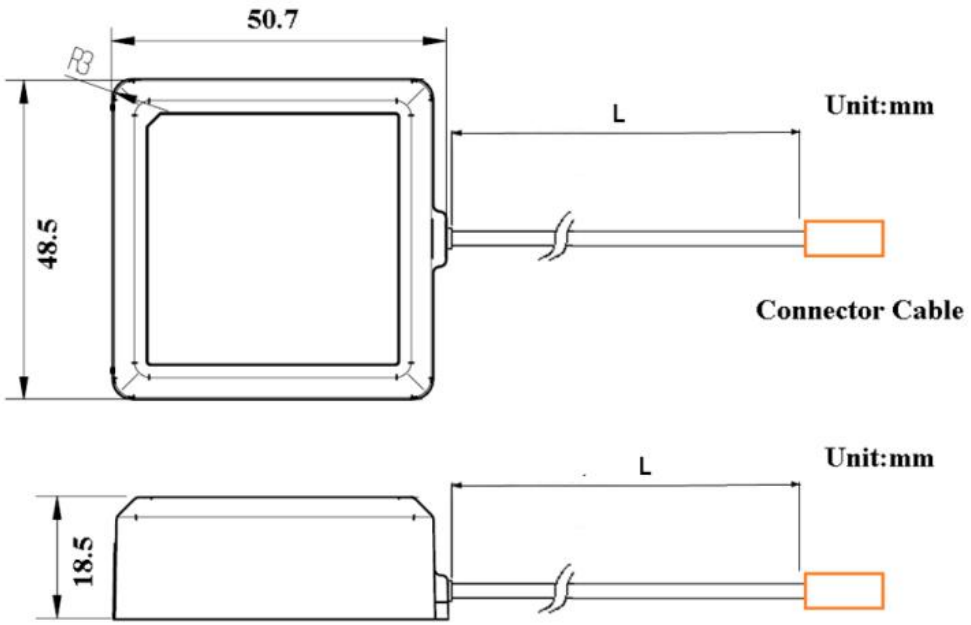


图 4 SKM2305NDR-40MXT Log/标签



线长/Line length	长度/Length（mm）
L	3000±50
L	5000±50
L	8000±50

图 5：SKM2305NDR-40MXT 尺寸

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 SKM2305NDR-40MXT 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 SKM2305NDR-40MXT 达到相同的性能指标，出厂前已经对 SKM2305NDR-40MXT 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 SKM2305NDR-40MXT sensor components (three-axis gyroscope, three-axis accelerometer) zero, sensitivity and temperature drift parameters are not the same, in order to make each SKM2305NDR-40MXT to achieve the same performance indicators, the SKM2305NDR-40MXT sensor components have been a variety of error compensation.

◆ **通信接口/Communication interface**

SKM2305NDR-40MXT 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 SKM2305NDR-40MXT 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 SKM2305NDR-40MXT 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 和 10hz 的数据刷新频率，默认频率为 1HZ。

Currently, the system supports the output data refresh frequency of 1hz and 10hz. The default frequency is 1hz.

12 注意事项/Matters need attention

SKM2305NDR-40MXT 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, SKM2305NDR-40MXT 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. 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 SKM2305NDR-40MXT，且无摇晃； Before the device is powered on, the car body is fixedly connected to SKM2305NDR-40MXT, and the module does not shake;	必须/Must
3	上电后，不能再移动 SKM2305NDR-40MXT； After the device is powered on, the SKM2305NDR-40MXT 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	SPS 模式/ SPS model
2	GNSS, SPS 模式/ GNSS, SPS model
3	PPS 模式/ PPS model

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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