HOW TO USE RBDS TO TRANSMIT DGPS CORRECTION MESSAGE

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ABSTRACT

This paper introduces the frequency spectrum characteristic of FM radio broadcast and the message format of RBDS (Radio Broadcast Data System). DGPS correction message in RBDS is described in detail. A design method of RBDS/DGPS system is proposed and the RBDS/DGPS system developed by us is introduced. Finally, some special advantages of RBDS/DGPS system are given.

KEYWORDS

FM radio broadcast, radio broadcast data system, global positioning system

INTRODUCTION

A reference station is necessary in DGPS system and the data communication between the reference station and the user stations must be provided. Generally, this kind of data transmission is wireless and

directional. In DGPS system, the reference station calculates the correction message of all visible satellites and encodes it into definite format (For example RTCM SC-104). Then the encoded message including pseudo-range correction and pseudo-range rate correction is transmitted real-time and continuously to the around GPS user.
At present, most of commercial data link is realized by vehicle transmitter-receiver which holds VHF (146~147MHz) or UHF (450~470HMz). Restricted by the antenna height and the transmission power, this kind of DGPS system only takes effect in the limited area. If we want to apply DGPS technology in wide area, many DGPS systems must be built and each DGPS reference station need a fixed frequency. But the frequency resource of VHF and UHF is scarce. Furthermore, it will spend a great deal of money. So this method is not worth adopting.
Above problem will not exist in the project that proposed in this paper, which uses FM sub-carrier to transmit DGPS correction message. And simultaneously, we researched and developed the RBDS/DGPS system. At the same time, if we want to apply it widely, related department's assistance is necessary.

FREQUENCY SPECTRUM OF FM RADIO BROADCAST

According to international standard, frequency spectrum of FM broadcast including stereo signal, RBDS and ACS is shown as figure 1.

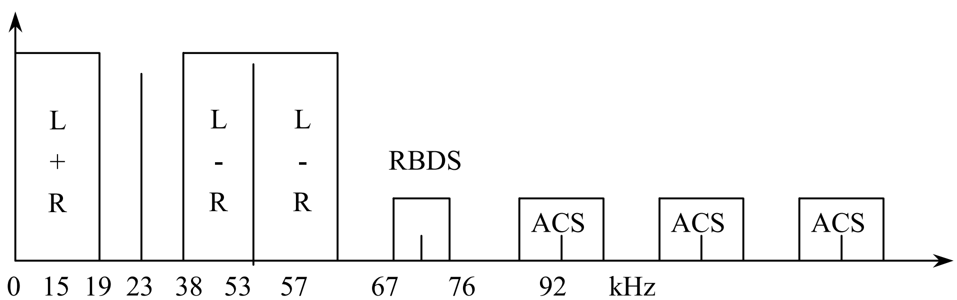

Figure 1. The frequency spectrum of the base-band of the broadcast FM

The frequency range of FM radio broadcast is from 87.5MHz to 108.0MHz and the bandwidth is 150kHz. The stereo broadcast is composed of two basic sound track signal that is L and R. They can construct L+R and L-R signal. From figure 1 we can find that FM broadcast including stereo signal only hold 53kHz bandwidth and don't hold total bandwidth distributed. The frequency band above 53kHz can be used to provide voice or data communication. At present, Radio Broadcast Data System (RBDS) which carrier is 57kHz and Assistant Communication Service (ACS) which carrier is 67kHz, 76kHz, 92kHz have been used to provide various services, for example, stock information, wireless call and traffic information in a few district. But in most districts, the frequency resources still haven't been applied.

MESSAGE FORMAT OF RBDS

In RBDS, the data signal is modulated on sub-carrier 57kHz and transmitted together with common stereo signal by broadcast transceiver.
RBDS signal is transmitted with data rate 1187.5bps and is encoded with dual phase shift keying. Its bandwidth is 4.8kHz. RBDS signal possibly concludes 16 data groups and the format of each group can be adjusted to adapt the requirement on different moment. As most serial data transmission system, RBDS divides each data group into several blocks. The longest group (104 bits) is divided into 4 blocks and each block includes 16 bits of data word and 10 bits of checkout word (Figure 2). The total serial data transmission is entirely synchronized and no inter-space is preserved.

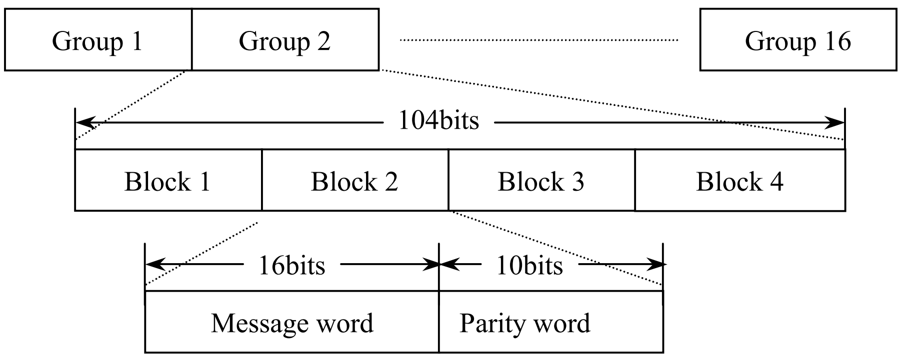

Figure 2. RBDS message format

The content of message word is shown as figure 3, which includes 16 bits of Program Identification Code, 4 bits of Group Type Code, 1 bit of Version Code, 1 bit of Traffic Program Code, 5 bits of Program Type Code and 37 bits of valid data. So data validation is 37 percent.

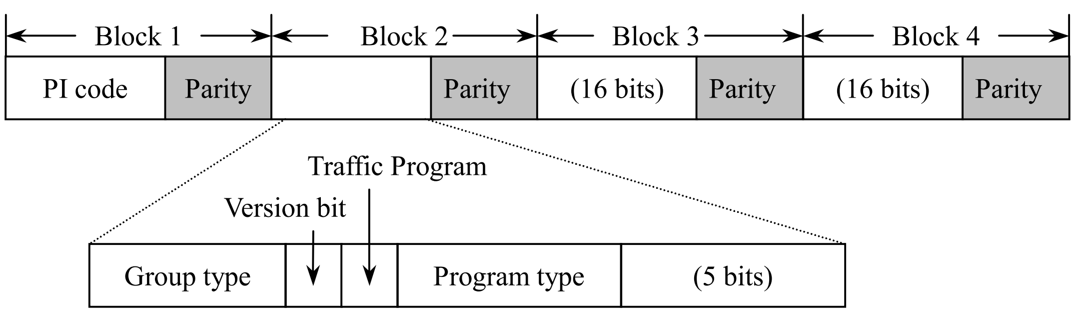

Figure 3. RBDS message word

The system adopts (26,16) abridged cyclic redundancy checks which can check 2 bits of random errors or 10 bits of abrupt errors and can correct 5 bits of abrupt errors.10 bits of checkout word is also used to provide group and block synchronization.

DGPS CORRECTION MESSAGE IN RBDS

4 bits of Group Type Code in RBDS message word defines thirteen kinds of group types and the third group can be used for navigation and location. It provides two kings of message. One is message of state (state name and coordinate) where the reference station is lied in and the other is DGPS correction message applied for location and navigation. This group of data provides an Address Code (2 bits) to indicate whether the message is of state or of DGPS. If the Address Code is 00 or 01, the message is of state. If the Address Code is 10 or 11, the message is of DGPS.

Because of special RBDS message format and signal bandwidth, RBDS can't directly adopt the RTCM SC-104 standard. The international RBDS work group recommended two kinds of basic formats that are correction data and assistant data about the third group of data. Figure 4 gives correction data format.

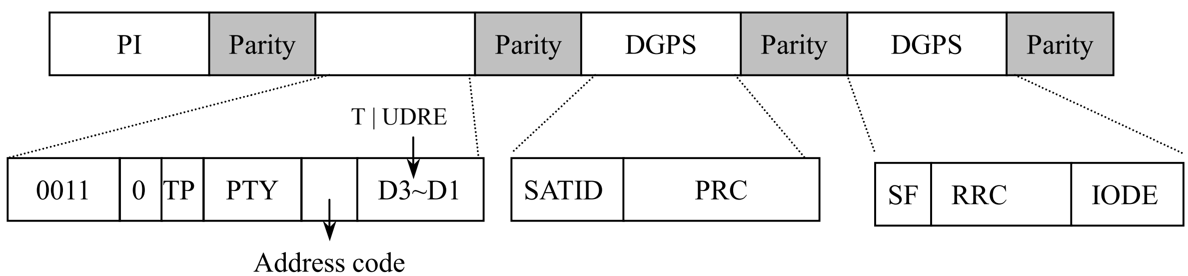

Figure 4. DGPS message in RBDS

DGPS correction message in RBDS includes following content.

User Differential Range Error (UDRE), Correction Time (T), Satellite ID (SATID), Pseudo-range Correction (PRC), Scale Factor (SF), Pseudo-range Rate Correction (RRC), Issue Of Data Ephemeris (IODE), etc.

CONSTRUCTION AND PERFORMANCE OF RBDS/DGPS SYSTEM

RBDS/DGPS system applies the spare frequency resource of ready-made FM broadcast. According to RBDS standard, the DGPS correction message is modulated on RBDS channel and transmitted to round GPS user.

The whole system consists of a base station and many user stations. The base station includes DGPS reference station, RBDS encoder, FM modulation and transmitter (Figure 5). The reference station composed of GPS antenna, GPS receiver and computer products DGPS correction message whose format is RTCM SC-104. Then it is encoded by RBDS encoder and transmitted by FM radio broadcast together with modulated stereo signal.

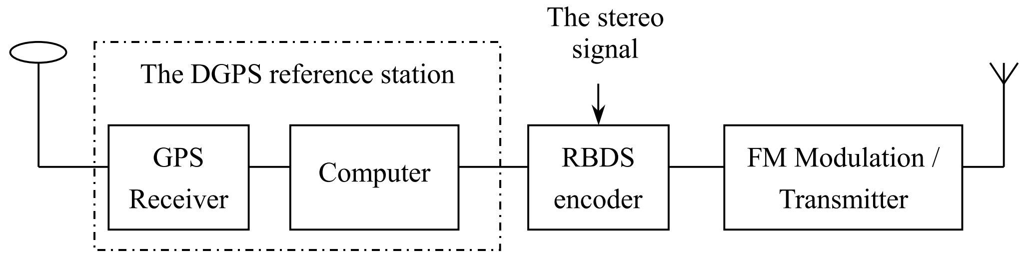

Figure 5. The base station of RBDS / DGPS system

The user station consists of RBDS/DGPS receiver, RBDS decoder and GPS receiver (Figure 6). RBDS/DGPS receiver receives FM signal from FM broadcast radio. DGPS correction message is filtered, demodulated and decoded and is restored to RTCM SC-104 base-band signal. GPS receiver can adopt the message to correct positioning result.

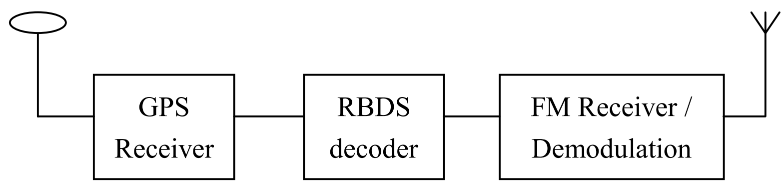

Figure 6. The user station of FM / DGPS system

The RBDS/DGPS system has following performance
(1) Main carrier frequency is 87.5~108MHz
(2) Sub carrier frequency is 57kHz
(3) Frequency bias is 4.8kHz
(4) Modulation method is dual phase shift keying
(5) Data transmission rate is 1187.5bps
(6) Code method is abridged cyclic redundancy
(7) DGPS message format is RBDS group type 3

CONCLUSION

In China, many big or moderate cities have FM radio broadcast and can be reconstructed to broadcast DGPS correction message. Many vehicles (for example police wagon and taxi) have FM receiver and can be reconstructed to receive DGPS message from FM radio broadcast. In addition relevant interface (TTL or RS-232) must be configured which is collected with GPS receiver. The RBDS/DGPS system costs little and doesn't hold extra frequency resource. It is very important in application of AVLN (Automation Vehicle Location and Navigation) system in city.

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