

# Accuracy Evaluation of Tracking Equipment Based on Star-Station- Difference Technique

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**Abstract.** An approach based on the star station difference technology is proposed for accuracy evaluation of tracking and controlling shipboard equipments in this paper. The proposed method has the advantages of simple equipment, convenient measurement, and low requirements on environmental conditions.

## 1. Introduction

The accuracy evaluation of tracking equipment is a important work. To ensure the calculating accuracy and dependability, the ground stations are established in the near region to provide the GPS difference messages. In this way, region restriction, high cost, low efficiency are the prominent problems.

This paper proposes a method for accuracy evaluation of tracking equipment based on star-station-difference technique. The proposed method has the advantages of simple, convenient, precise, automatic, and low requirements on environmental conditions <sup>[1]</sup>.

## 2. The star-station-difference technique

By the star station difference technology, the GPS difference correction signals broadcast by satellites instead of the stations on the ground. It makes the receivers can receive the difference correction signals and high precision positioning is provided on the open sea. In the Last century ninety's, foreign countries began to study the development of Star Station difference GPS. There are many system such as : CDGPS, OmniSTAR system, SeaSTAR system, Skyfix system , StarFire<sup>[2,3]</sup> system and Veripos system. StarFire<sup>[2,3]</sup> system, Veripos system and OmniSTAR system are commonly used in China.

The StarFire system is one of the star station difference systems. The whole system consists of five parts: the reference station, data processing center, data immit station, INMARSAT and user station. Global reference station network is composed of dual-frequency GPS receiver which receive signals from GPS satellites. Data from reference station are sent to the processing center. After being processed, the differential correction data is generated. The differential correction data transmit data communications link to the immit station and upload to the INMARSAT in the world. At the same time, user station GPS receiver which having two actually receiving part receive the correction signals. The GPS receiver track all visible satellites and then obtain the measured value of the GPS satellites, the L-band communication receiver correct the data by L-band satellites signals. When the correct data are used in GPS measurement, the real-time high-precise positioning is done.

## 3. Accuracy testing



### 3.1. Precision identification

Precision identification<sup>[4]</sup> is used to test and evaluate the dynamic performance and accuracy of the aerospace measurement and control equipment, and to analyze the variation of its error, and to test whether the technical indicators meet the design requirements<sup>[5]</sup>. It is the premise to obtain accurate target data from the measurement and control equipment, which is great significance.

### 3.2. Existing problems

GPS precision identification system is the only way to evaluate the accuracy of TT&C equipment. The system need RTK system by land differential measurement station, eliminate the error by using differential station, Airborne GPS, ship borne GPS. Differential positioning technology requirements that the distance between substation and dynamic measure point is short as possible. It is difficult to choose a GPS station for every test of evaluation. It is urgent to find a new technical means to reduce the cost, optimize the system work way and improve the working efficiency.

### 3.3. Star Station difference application

Star Station differential system in the application of Survey ship exploration began in 2008. The previous carrying test show that, star station difference technology can effectively improve the position accuracy, and further improve inertial navigation position calibration accuracy, timing accuracy and tracking fixed rail precision. It is of great application value. In order to further deepen the application of the star station differential technique in the survey ship, it has been demonstrated that using star station differential technique in precision identification of the measurement equipment is feasible.

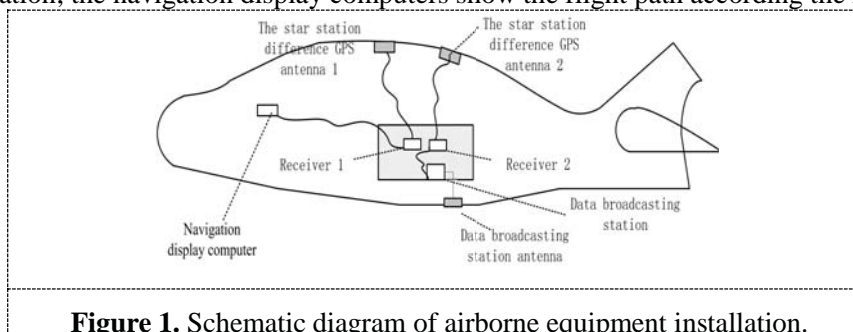
In May 2014, the StarFire system was used in the test of precision identification as a backup method of the GPS precision identification system. Test results show:

- a. The dynamic index (nominal value) of Star Station differential equipment meets the requirements of ship navigation and flight dynamics;
- b. The data precision of the Star Station differential equipment is quite the same as the accuracy of the existing precision identification system;
- c. Star Station differential equipment is feasible in the measurement of the ship's accuracy.

## 4. Accuracy Evaluation Scheme

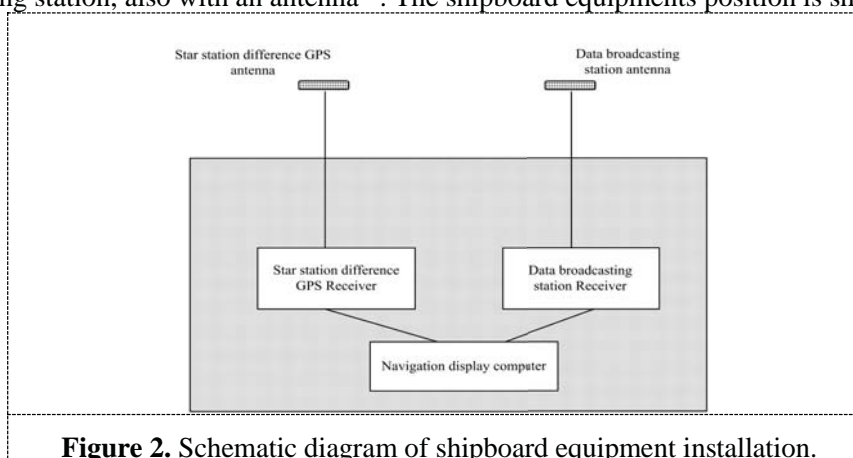
### 4.1. Airborne subsystem

The airborne subsystem is composed of GPS antenna, navigation display computers, GPS receivers and data broadcasting station with antenna. The airborne equipments position is shown in Figure 1, two antenna are installed on the plane to receive the GPS difference correction signals. The airborne subsystem measure the real-time plane's position, velocity and attitude which broadcasted by the broadcasting station; the navigation display computers show the flight path according the received data.



### 4.2. Ship carrying subsystem

The shipboard subsystem is composed of GPS antenna, navigation display computers, GPS receivers and data broadcasting station, also with an antenna<sup>[3]</sup>. The shipboard equipments position is shown in Figure2.



**Figure 2.** Schematic diagram of shipboard equipment installation.

Compared with the conventional GPS precision evaluation system, the star station difference technology has the following advantages: high real-time pointing precision, simple equipment, convenient measurement, , low requirements on environmental conditions, low economic cost and easy scheme design.

#### 4.3. Data processing subsystem

The data processing subsystem is composed of a high configuration computer. Its function is calculating the position and attitude data of the airborne subsystem and the ship carrying subsystem, and providing high accuracy data for comparison. It can be installed on the land or on the ship.

#### 4.4. System composition

Table 1 includes the equipments of accuracy identification system.

**Table 1.** The equipments of accuracy identification system.

	equipment	position
Airborne subsystem	Digital radio	Frame
	Digital radio antenna	Lower part of the fuselage
	Satellite station differential antenna	Upper fuselage
	Satellite station differential receiver	Frame
	Air display computer	Cockpit
Ship carrying subsystem	Digital radio	Cabin
	Digital radio antenna	Deck
	Satellite station differential antenna	Deck
	Satellite station differential receiver	Cabin
	Air display computer	Cabin
Data processing subsystem	Data processing computer	Cabin
	Data processing software	Computer

Through the analysis and comparison, it can be seen that the difference between the Star-Station-Difference system and the old identification system. The Star-Station-Difference system has the following advantages:

- a. Real time positioning accuracy is high. The high accuracy position data can effectively reduce the influence of position error, so as to improve the accuracy of measurement.
- b. The data can be used directly for comparison, reducing the amount of post data processing workload and improving Measurement accuracy.
- c. high integration, high reliability, stand-alone operation, simple installation.
- d. Reference station is not necessary.

## 5. Conclusion

This paper proposes a scheme of accuracy evaluation of tracking equipments. By the star station difference technology, the GPS difference correction signals broadcast by satellites instead of the stations on the ground. It makes the receivers can receive the difference correction signals and high precision positioning is provided on the open sea. It makes the dynamic precision evaluation of shipboard equipments feasible and easy.

## References

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