Implementation of a performance analysis system for a space-grade receiver using MIL-STD-1553B : EGSE(Electrical Ground Support Equipment)

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Abstract_  EGSE (Electrical Ground Support Equipment) is a device supporting ground test of satellite electronic equipment, assembled / integrated on the ground to control various hardware including measuring equipment and this hardware Perform satellite performance test.  EGSE, which can analyze the data of the test results of the receiver performed on the ground before actually launching the satellite, acts as an important element before the launch of the satellite[1]. It is one of the necessary elements to analyze the function and performance of hardware, to derive software design defects, and to carry out smooth tasks in the universe. In this paper, we have developed a system that can measure the accuracy and reliability of receivers installed in satellite bodies, and have already developed the Space-grade Reference Receiver used in the space environment and the newly developed receiver Develop software that can collect data of receiver at 56MHz and compare and analyze performance. We also develop monitoring software that can compare data in real time based on packets of multiple commercial receivers. This can test the receiver which has already tested in the universe and the performance before launch, replicate the space environment and analyze the various receivers together in an extreme situation, and derive the result be able to. As a result, TM (Telemetry Message) / CM (Command Message) of MAJOR / MINOR FRAME is used as the main communication system by using highly reliable MIL-STD-1553B. This allows you to adjust the output frequency and communication frequency of data and it can be easily applied to existing MIL-STD-1553 B 8 Hz Time Division Frame Scheduling System.

Keywords—EGSE(Electrical Ground Support Equipment), MIL-STD-1553B, Data acquisition, Telemetry Command, Receiver Develop, Development receiver, Space Receiver Monitoring

I. INTRODUCTION  
EGSE (Electrical Ground Support Equipment) is a device supporting ground test of satellite electronic equipment, assembled / integrated on the ground to control various hardware including measuring equipment and this hardware Perform satellite
performance test. It is one of the necessary elements to analyze the function and performance of hardware, to derive software design defects, and to carry out smooth tasks in the universe. Furthermore, the software is fluid and requires test support, and data verification by test is carried out. In this paper, we constructed a data collection and monitoring system to analyze the performance of the receiver which is one of EGSE performance tests. Through the scheduling of the time division frame of the MIL-STD-1553B communication protocol, we compare and analyze the data of the receiver used for the actual satellite and the data of the receiver developed in the satellite, and compare and analyze the data for the algorithm and UI implemented[2]. The communication protocol (MIL-STD-1553B) for the implementation of this system is a fieldbus developed for use in the US Navy and the Air Force, utilizing a network with a bus topology structure and using a 1 Mhz half-duplex transmission scheme use.

II. SYSTEM CONFIGURATION AND DESIGN
In order to test the performance of the receiver, which is one of the functions of EGSE, this paper selects two commercial space-grade receivers as a receiver to be compared and uses two commercially available simulators. Save the same universe scenario and create an Input Signal. Each receiver receives the scenario being played, creates operation information, the created operation information is monitored via software using MIL-STD-1553B, and at the same time utilizes SERIAL communication. Save the data to 50 Mhz and monitor the operation information. The configuration for the experiment is the same as Figure 1.

Figure 1: System Configuration
There are two types of satellite signals, Live Signal and Simulator Signal. Live Signal compares Navigation based on data currently being used in real time by GPS / GLONASS / GALILEO. Simulator Signal is a method of recording past data and sending it to the receiver. The developed monitoring software receives this Signal and sends a Command to the receiver. The receiver receiving the command transmits the operation data required by the software by the command, and receives the highly reliable data and compares the two receivers via the MIL-STD-1553B become. The receiver outputs the satellite navigation data in the binary type once per second and detects the communication error and the operation data error via 1pps data collection.

A. Setting of receiver and hardware communication
In order to support the performance test and the environmental test of the satellite navigation complex receiver, we have constructed a simulator for low-earth-orbit environment satellite navigation replication. The GPS RF signal is received by the satellite antenna or generated by the GNSS Simulator,
and connected to the Reference satellite receiver and the GNSS QM Board via the RF Splitter.

Figure 2: Dev. EM Rcv. Comm. Module

Reference Satellite receiver and QM BOARD are connected to the EGSE server via MIL-STD-1553 B and connected to a server for collecting data via RS-422 and Serial COM PORT. The configuration of the QM BOARD communication module is as shown in Fig. It is the same as 2. For reliable comparative analysis of the simulator and operation data, we used two simulators from different manufacturers, respectively, and recorded traveling data by recording low-earth-orbit environment satellite navigation simulation. Based on the scenario generated by the simulator, the MIL-STD-1553B protocol is transmitting without loss of data, and data logging is possible using Serial communication for MIL-STD-1553 B data verification.

B. Configuration and design of EGSE software

The software unit consists of a total of three parts. A serial monitoring unit capable of monitoring data of two receivers and data output by Serial, an analyzing unit capable of storing and analyzing the received operation data at 56Mhz, a reference receiver and an QM receiver. It is possible to compare the operation data in real time and it is divided into the data analysis unit. Each software is operated independently.

C. EGSE (Electrical Ground Support Equipment) Server

EGSE monitoring software implemented BINARY data converted to ASCII to confirm the performance comparison analysis of the receiver by the user. LOG CONTROLLER was placed to determine the data of RT # 1 (Reference receiver) and RT # 2 (QM receiver).

Figure 3: MIL-STD-1553B Sequence Diagram

In order to use the TM / CM of 1553 B, we construct a module of Command generator and receiver, and 1553 B message uses a method of outputting necessary operation data when receiving a command via CM. The block diagram and structure of the EGSE Server are structured as shown in fig 4.
D. Navigation data acquisition and monitoring software

The operation data monitoring software monitors the data of the low-earth-orbit satellite navigation scenario in real time, receives the Telemetry Data, and confirms the state. At the time of the test, the state of the real-time satellite navigation signal is monitored, data is received to judge the presence or absence of an interference signal at the time of progress of the scenario, and an analysis function is executed. Then compare the state of the navigation signal with the Reference receiver. In addition, the information processing, storage and communication interface of GNSS satellite was composed. The configured interface calculates receiver raw data processing and PVT (Position, Velocity, Time).

II. RECEIVER INTEGRATION TEST

A. Summary of integration testing

The integrated test of the receiver compares and analyzes the test data of the Reference receiver and the QM receiver. Using the space scenario, we monitor real-time operation data and perform comparative verification in real time. We compare and analyze logging data of about 30 minutes and compare/verify the precision of the receiver of the development and the reference data of the scenario. The verified data can be confirmed by the user in real time, postprocessing is possible using the saved LOG. Validation using postprocessing can detect algorithms that show better performance by using several algorithms developed in the past. This can be the basis for improving the performance in developing the new firmware of the receiver.

B. Integration test

The integration test monitors real-time data received by RT #1 and RT #2 and compares them to two commercial receiver models. Testers conducted comparative analysis using comparative data. Fig 5 is real-time collection software for monitoring RT #1 and RT #2.1

C. RF Data Acquisition Test

In order to verify the performance of RF data collection, a test environment was constructed as follows. Then collect RF data and confirm that you are collecting normal data at 56 MHz speed. Fig 6 is
the configuration of the environment for data collection.

![RF Data Acquisition Configuration](image)

The developed data collection program was used to collect data through USB 3.0 interface. In order to check data occurrence seamlessly or error occurrence, after inputting 0 to 254 patterns, data was received and file pattern check was executed several times to confirm that there was no error. After confirming execution of normal data collection function, RF Front-End and Baseband were connected. Live or scenario 56 MHz Sampling data saved in the file after collecting RF data was collected and verified.

D. Postprocessing Data Validation
The result of post-processing of the collected data is output as Fig 7.

![Alcatel Position Error](image)

Figure 5: PVT & Error Comparison result

III. CONCLUSION
When the ground test support apparatus is not constructed, it is not possible to flexibly change the algorithm of the satellite broadcasting receiver. For this reason the EGSE test must be very thorough and important. Therefore, MIL-STD-1553B which is one of highly reliable communication methods was used for performance analysis of major receivers in this paper. Therefore, MIL-STD-1553B which is one of highly reliable communication methods was used for performance analysis of major receivers in this paper.
Performance analysis of Reference receiver and developed receiver was carried out based on 1hz and 8hz signal. By using EGSE Server, dynamic experiments can be done for comparative analysis of each protocol, and analysis of data between receiver modules was easy. Therefore, the receiver developed in this paper has a position error range within 15 m and the speed error range up to 0.3 m / s compared with the Reference receiver. We showed satisfactory results using EGSE. In addition, Monitoring Software got the calculation results by operating normally. Through postprocessing data analysis, we were able to detect algorithms that deliver better performance using existing existing algorithms developed. From now on, this software seems to occupy a very important part for the testing of the receiver being developed, and it seems to

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