Header Data Interpreting S/W Design for MSC(Multi-Spectral Camera) image data

Jong-Pil Kong
Korea Aerospace Research Institute
45 Eoeun-Dong, Yuseong-Gu, Daejeon, 305-333, Korea
kjp123@kari.re.kr

Haeng-Pal Heo, YoungSun Kim, Jong-Euk Park, Heong-Sik Youn
Korea Aerospace Research Institute
45 Eoeun-Dong, Yuseong-Gu, Daejeon, 305-333, Korea
hpyoung, yskim1203, pje, youn@kari.re.kr

Abstract: Output data streams of the MSC contain flags, Headers and image data according to the established protocols and data formats. Especially the Header added to each data lines contain information of a line sync, a line counter and, ancillary data which consist of ancillary identification bit and one ancillary data byte. This information is used by ground station to calculate the geographic coordinates of the image and get the on-board time and several EOS(Electro-Optical Subsystem) parameters used at the time of imaging. Therefore, the EGSE(Electrical Ground Supporting Equipment) that is used for testing MSC has to have functions of interpreting and displaying this Header information correctly following the protocols. This paper describes the design of the header data processing module which is in EOS-EGSE. This module provides users with various test functions such as header validation, ancillary block validation, line-counter and In-line counter validation checks which allow convenient and fast test on imagery data.

Keywords: MSC, EOS-EGSE, header, ancillary data

1. Introduction

The MSC is a space-borne payload system carried by a satellite orbiting the earth in a given altitude and providing imagery of selected stripes along the satellite's track in the visible and NIR spectral ranges. It will perform the main mission such as surveillance of large scale disasters and its countermeasure, acquisition of high resolution images for GIS, composition of printed maps and digitized maps, etc. The imaging method of this system is based on the "push-broom" principle, i.e., as the satellite advances it covers the earth surface along its track, enabling the MSC to capture the images as it passes them. Then, these images are converted to digital data, handled by the system and processed in order to either store and/or transmit to the GS(Ground System). For these purpose, the MSC employs three parts of EOS, PMU(Payload Management Unit) and PDTS(Payload Data Transmission Subsystem). EOS generates imagery using optical sensor and PMU controls the overall operation of MSC while PDTS is in charge of data transmitting, processing including compression etc.. But, NUC(Non-Uniformity Correction) board, which also functions as one of data processing modules locating in PMU and accepting the imagery data(pixel stream and line count) from the EOS via high speed data link, dose non-uniformity calibration to calculate the corrected values for each pixel, formats the data into their video format, adds the ancillary data as received from OBC (On-Board Computer) and PMU, and then forwards the processed data to the PDTS. The data stream formats for NUC input and output are presented in Fig. 1. So, in order to check and verify the functionality and performance of EOS and NUC which deal with imagery flows as well as to support integration of MSC some special equipments are required. In this paper, details on design of interpreting S/W module of the Header information, which is being used in EOS EGSE, shall be explained. The overview of EOS EGSE, therefore, is described first This S/W module provides users with various test functions such as header validation, ancillary block validation, line-counter and In-line counter validation, which allows convenient and fast test on imagery data.

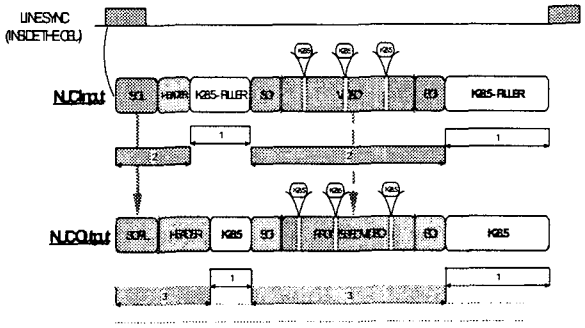

Fig.1 Data Stream of NUC

2. EOS EGSE General Capability

The main purposes of EOS EGSE could be described as checking and verifying the functionality and performance of MSC data flows from EOS during EOS unit test. In addition to that, it also should have capability to check and verify the functionality and performance of PMU

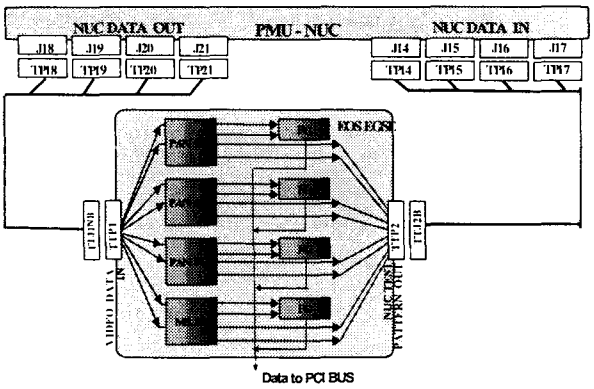

Fig. 2. NUC image I/F of EOS EGSE

NUC during PMU test with the assistance of PMU EGSE that operates, controls, and monitors the PMU under test. And at the last stage of development it is also used to support MSC integration by checking the functionality and the performance of EOS and PMU together while integrated by providing display services for the image data that is collected from MSC output. EOS EGSE, therefore, should be capable of providing simulated image data at the input of the PMU NUC and acquiring image data at the output of the PMU NUC as shown in Fig. 2 as well as EOS under test. In the Fig. 2 each FGI sends test pattern image data which was simulated by EGSE S/W to NUC and receives data which was corrected by NUC function from NUC. It should also operate the target monitor controller in conjunction with testing the EOS under test and synchronize image data acquisition with target motion or Time Mark signal when required by individual test of the EOS or PMU NUC test. Other than these, conducting electro-optical performance tests using the image data that was acquired from the EOS is another main requirement. It should also have the capability of operating, controlling and monitoring the EOS under test by providing the input power, establishing communication, implementing thermal control and monitoring the status reports in order to support the tests to check normal heater operation in EOS.

3. Design of S/W

Header interpreting S/W is mainly for testing the validation of Header information including Ancillary data by analyzing collected NUC output stream data. It consists of several modules processing input files to perform tests and generating output files which show test results. Details on input, output file and test operations are explained below.

1) General

Header interpreting S/W reads Header Data file that was recorded or generated by the EOS EGSE by the retrieval path of the PMU NUC simulator and assists the operator with conducting all the required Header Data test and verification. Therefore in general, it reads the input Header Data files, conducts the proper search, lock activities to guarantee interpretation and testing of valid data. That is, it interprets and displays the collected Header Data to the operator while properly grouped with proper browsing features and indication for abnormal data. It has the capabilities of implementing automatic testing for the contents of the Header Data to maximum possible extent and providing the proper data for manual verification of the test that can not be automated. Generating detailed reports and logs that give summary data of the errors found during the screening of the input Header Data files with detailed allocation data for each of the errors found is another requirement that is necessary for a convenient test.

2) Interfaces with input files

The Header Data S/W shall be capable of opening and processing the input files, for the preparation of data analysis, that are listed and defined below.

Header Data file

In a binary data file format that is recorded by the MSC EOS EGSE or by the retrieval path of the MSC PMU-NUC Simulator this file is characterized by containing the MSC Imagery Data Header (i.e. the Header information that is attached to the Image data at the PMU-NUC) only or containing large amount of headers (up to and more than 40,000 – 50,000), where each entry / record contains the header information of a single MSC video line ,or containing leading information (internal header) of the "commanded line rate" as recorded by the EOS EGSE.

Satellite Ancillary Data file

This file is provided by satellite simulator in a binary data file, and is characterized by containing Satellite Ancillary Data only for simulating KOMPSATII Ancillary Data for MSC tests. It contains integer number (10 max.) of full Satellite Ancillary Data blocks of Satellite Ancillary Data, lined byte after byte and second after second without any control characters or markers between the seconds.

Line&In-line Measurement Data file

This file is recorded by the MSC EOS EGSE during PMU-NUC output data tests in a text data file format and characterized by containing the measurement results of Time Mark events in terms of Number of Line and In-Line counter only, as measured by the EOS EGSE FGI and also containing about 1 to 5-6 records, with each record including a counter for Number of Line and In-Line counter.

Configuration file

This file must be prepared by the Header Data S/W designer in windows INI file structure, and is characterized by containing the reference parameters for the tests that shall be conducted by the Header Data S/W, including, but not limited to the required patterns for the Header Sync and End Sync, the MSC data channels An-

cillary/No-Ancillary configuration, the required pattern for the Header data of the No-Ancillary channels and the required identification channel codes used in the Header.

3) Interface with output files

As test results during operation, the Header Data S/W generates the output files that are listed and defined below to provide users with necessary information for analysis.

Execution Log File

It lists all the execution events during a single run (i.e. from start to stop or from start to completion) and includes date and time of the recorded event series and names of input and output files that were handled, opened, generated, etc. during SW run.

Error Log File

This file, in a Text data format, lists all the erroneous events during a single run with a file name containing the file type (i.e. "xxx_Error") and the PC date and time when the file was opened, where "xxx" specifies the error type.

Other than these, Event Log file and output Satellite Ancillary Data file are generated.

4) Test Operations

Header Data interpreting S/W was designed to incorporate and conduct the below listed and specified data test while checking and interpreting the input Header Data files. The entire group of tests is conducted for each run of this S/W. Tests are divided into Header validation test, No-Ancillary validation test, Block search & lock test, Line number and quantity test, Identical blocks test, Auto data test, Event test, APS data test, Satellite Ancillary validation test and Line & In-Line reports validation test. Some of these test results are shown in Fig. 3.

Header validation Test

This test is for the validation of the "envelope" of all the headers that were recorded in the input Header Data files and validation of the consistency of the constant items and the sequencing items of the Header. It checks the consistency of the Sync Marker, End Marker, Channel ID Marker of the Header and checks if the Line Counter increase sequentially. As a test results, it reports the total number of headers found in the input Header Data files and the pass/fail statistics for each of the tests with the total number of errors that was encountered in each test. It also reports the starting and ending readings of the Line Counter that were found in the input fiels.

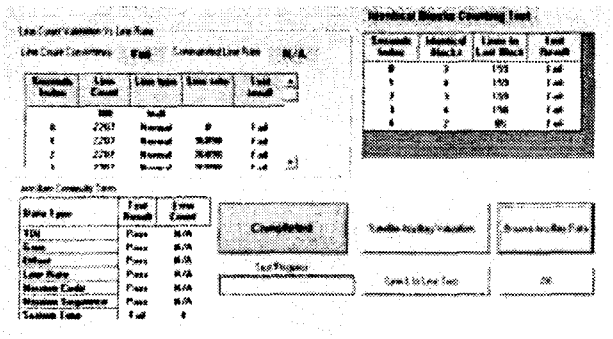

Fig. 3. Validation Test results

No-Ancillary validation Test

This test reads the input Header Data file and checks consistency of the constant items of the ancillary area of the header in case of No-Ancillary channels in which no Ancillary information is attached. It also checks the validity and consistency of the no-ancillary pattern on input files. As a result, it reports pass/fail for no-ancillary consistency.

Block Search & Lock Test

The Header Validation Test and the No-Ancillary Validation Test verify the entire header except the Ancillary ID and the Ancillary Data area, which are not checked (except for No-Ancillary condition / indication). Therefore, these tests are conducted on the line level while processing and validating line after line. All the other tests that are implemented in the Header Data S/W require detailed review and interpretation of the Ancillary ID and the Ancillary Data area, where the data item reported by each byte is related to the allocation within the Ancillary Data Block (512 bytes). Also, during normal data flow out of the PMU-NUC, lines changes from Null line to "regular" lines and then the Ancillary Block is replaced every second. Resulting, before any detailed review and interpretation of the Ancillary ID and the Ancillary Data area, the search and lock test must first lock on the Ancillary Data Block. However, the search and lock (as all the other test below) should be omitted when No-Ancillary condition is encountered. This test searches the input Header Data file from the first line while calculating the check-sum for a group of consecutive 512 Ancillary data bytes and checking versus the check-sum included in the block that was calculated. If check-sum does not match, repeating the calculation with the block started one line below the previous one. When a check-sum match is found, it completes the validity check of the block by checking if the Ancillary ID is strictly sequential from "0" to "511". Check-sum calculation is done for the entire block, excluding bytes for Line & In-Line data. Check-sum compare is done by comparing the 2 low bytes of the calculated check-sum with the reported check-cum bytes of the block.

Line Number Quantity Test

This test checks the validity and consistency of line number quantity over the entire recording of both regular and Null line. It counts all valid lines in each "transmission second" of the input Header data file and then checks stability of the line quantity and verifies this counter values versus "Line Rate" which is reported in the Ancillary Data bytes. The counts for MS channels must be multiplied by 4 before comparing to the reported

Line Rate because the reported Line Rate is for PAN channel.

Identical Block Test

Identical Blocks Test checks the Validity and consistency of Ancillary Data parameters that should be consistent during the entire recording. It Compares all the validated blocks of a "transmission second" to the first validated block of that "transmission second" while counting the validated blocks of each "transmission second". And it verifies regular incrementing of the parameters such as system time at each and all the lines of the input Header Data file while counting the lines in error and location (in terms of line number) and contents of all the errors.

Event and APS Data Test

These Data Tests prepare the data for manual verification of the Event reported over the Ancillary Data by listing all the Events that were recorded on the input Header Data file. They apply for the validated blocks only.

4. Conclusions

As a unique payload in KOMSAT2 MSC captures and transmits image data according to the established communication protocol, and data formats which includes header information which should be interpreted correctly to get a necessary information in ground station. This paper described the design of interpreting S/W of header information, which is used for testing of NUC that composes header data formats following a protocol. It was designed using modular concept and provides users very fast and convenient methods for checking the validity of header information to verify the functionality of NUC board. This S/W can be also used for other projects which use similar protocol architecture and data formats with some modification accordingly.

References

[1] EOS EGSE Requirement Specification
[2] PMU EGSE Requirement Specification
[3] NUC Hardware Assembly Specification
[4] MSC X-Band to Ground Interface Control Document
[5] MSC Operational Handbook