An analysis of Electro-Optical Camera (EOC) on KOMPSAT-1 during mission life of 3 years

Hyun-Chul Baek[†], Sang-Soon Yong, Eun-Kyou Kim, Heong-Sik Youn and Hae-Jin Choi
Satellite Mission Operation Department, Korea Aerospace Research Institute
P.O. Box 113 Yuseong-gu, Daejeon, Korea
sn100@kari.re.kr[†]

Abstract: The Electro-Optical Camera (EOC) is a high spatial resolution, visible imaging sensor which collects visible image data of the earth's sunlit surface and is the primary payload on KOMPSAT-1. The purpose of the EOC payload is to provide high resolution visible imagery data to support cartography of the Korean Peninsula. The EOC is a push broom-scanned sensor which incorporates a single nadir looking telescope. At the nominal altitude of 685Km with the spacecraft in a nadir pointing attitude, the EOC collects data with a ground sample distance of approximately 6.6 meters and a swath width of around 17Km. The EOC is designed to operate with a duty cycle of up to 2 minutes (contiguous) per orbit over the mission lifetime of 3 years with the functions of programmable gain/offset.

The EOC has no pointing mechanism of its own. EOC pointing is accomplished by right and left rolling of the spacecraft, as needed. Under nominal operating conditions, the spacecraft can be rolled to an angle in the range from +/- 15 to 30 degrees to support the collection of stereo data.

In this paper, the status of EOC such as temperature, dark calibration, cover operation and thermal control is checked and analyzed by continuously monitored state of health (SOH) data and image data during the mission life of 3 years. The aliveness of EOC and operation continuation beyond mission life is confirmed by the results of the analysis.

Keywords: EOC, SOH, KOMPSAT, Payload

1.0 INTRODUCTION

The Electro-Optical Camera (EOC) is a high spatial resolution, visible imaging sensor which collects visible image data of the earth's sunlit surface. The EOC is the primary KOMPSAT-1 satellite payload. The purpose of the EOC payload is to provide high resolution visible imagery data to support cartography of the Korean Peninsula. The EOC will collect image data from sunlit earth scenes in the broadband visible wavelength (also called the panchromatic band). The collected data along with ancillary spacecraft position, attitude, and time data will be processed by the KOMPSAT ground station to produce standard and value added image products such as cartographic maps. The EOC is a push broom-scanned sensor which incorporates a single nadir looking telescope. The sensor is rigidly attached to the top of the spacecraft payload module and the optical boresight of the telescope is aligned with the spacecraft +Z direction. At the nominal altitude of 685Km with the spacecraft in a nadir pointing attitude, the EOC collects data with a ground sample distance of approximately 6.6 meters and a swath width of 15Km. The EOC is designed to operate with a duty cycle of up to 2 minutes (contiguous) per orbit. The EOC has no pointing mechanism of its own. EOC pointing is accomplished by rolling the spacecraft, as needed, so that the line of sight of the EOC passes over the desired location or swath. This swath pre-pointing is performed several minutes prior to a collection pass via stored command execution. Under nominal operating conditions, the spacecraft will be rolled to an angle in the range from +/- 15 to 30' to support collection of cartography data. The spacecraft point the EOC for left and right viewing on separate orbits to collect stereo data. The spacecraft has a roll capability of +/-45' to support special imaging revisit cases.

In this paper, the aliveness of EOC and operation continuation beyond mission life is confirmed by the results of the analysis.

2.0 EOC INSTRUMENT DESCRIPTION

The EOC has been developed to provide high resolution image data with GSD less than 6.6m over swath width of 15 km by push-broom scanning method at the altitude of 685km. And hard ware consist of sensor assembly and electronics assembly and spectral band on ground for topography monitoring in the 510nm to 730nm range are selected and used to specify instrument performance.

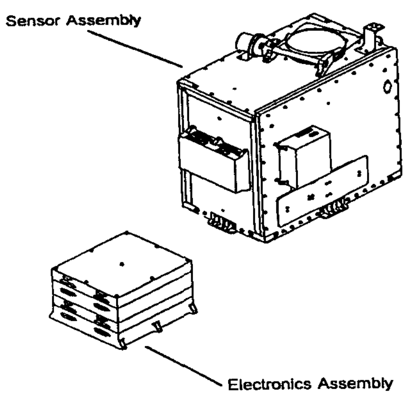

Figure 1. EOC Electronics & Sensor Assembly

3.0 EOC OPERATION DESCRIPTION

The KOMPSAT EOC was designed to provide topography data of the Korean Peninsula from 685 km altitude sun synchronous orbit. The orbit crossing time is at 10:50 AM and the inclination is 98.13 degree. The EOC instrument performs push-broom scan imaging operation with a ground sample distance (GSD) of 6.6m and a cross-track ground swath of 15 km. The ground track re-visit time is 28 days.

The EOC instrument was designed to perform imaging operation for 20% per orbit and The image data are digitized and lossless compressed before being transferred to the payload data transmission subsystem (PDTS) as date rate of less than 1Mbps. PDTS will support worldwide imaging operation by providing data archive to on-board solid state recorder (data storage at the begin of life: 3Gbits) and X-band downlink of image data to the KARI ground station (KGS) at Taejon, Korea.

4.0 EOC FUNCTIONAL STATUS ON ORBIT

Once KOMPSAT-1 is launched, EOC heater is tuned on to conserve temperature in range 0 to 45 degrees centigrade and after outgassing period of 2 weeks is passed to protect instrument from contamination although spacecraft are checkout for normal mission operation, main aperture of EOC which is one time open and the initial checkout of EOC is started. During 3 years scanner, dark calibration, imaging interface, gain, offset and mission scenario so on are performed and analyzed as the following section.

4.1 EOC ANALYSIS SEQUENCE

The analysis of EOC is performed dark calibration, temperature through Telemetry (TLM) from launch to May, 2003 and the stabilization of spacecraft is confirmed period of 3 years.

External electrical interface between spacecraft and EOC, like power interface, discrete command interfaces, 1553B command interface, and image interface and EOC status, such as power status, mirror status, temperature status and image data status are checked through normal operation. EOC cover open interface, band selection interface, and image interface of different gains and offsets setting are also checked during normal operation. The results of analysis are described in the following section.

4.2 THE STATUS OF DARK CALIBRATION

The allocated maximum data transmission for EOC is 1 Mbps through Transparent Asynchronous Transmitter-Receiver Interface (TAXI) and in order to meet it EOC use lossless compression encoder, USES and the analyzed results of each mode is shown in Figure 2 and all of acquired data are satisfied with data transmission rate. The usage of SSR, 3Gbit can be estimated before mission operation of the topography of the Korean Peninsula monitoring dark calibration. The analysis of Dark Calibration on EOC is performed pixel 150 of 2000

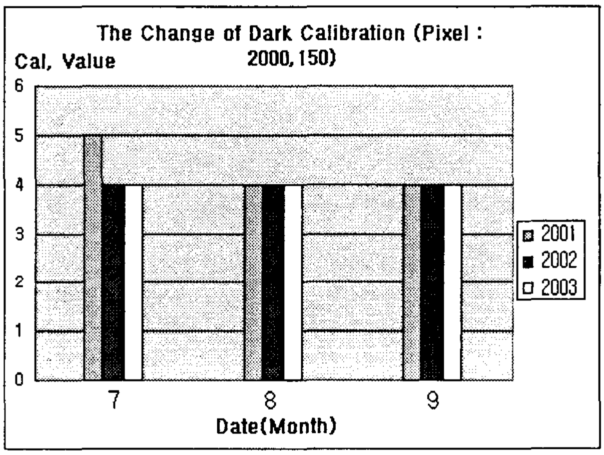

Figure 2. Compare to monthly

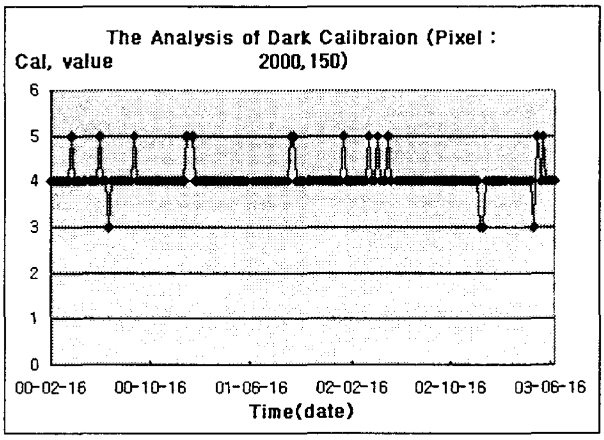

Figure 3. The change of Dark Calibration

Figure 2 is to express the change of the dark calibration comparing with month which is satisfied requirement and Figure 3 is to express the change of the dark calibration from launch to Sep, 2003 which is satisfied requirement.

4.3 THE STATUS OF TEMPERATURE

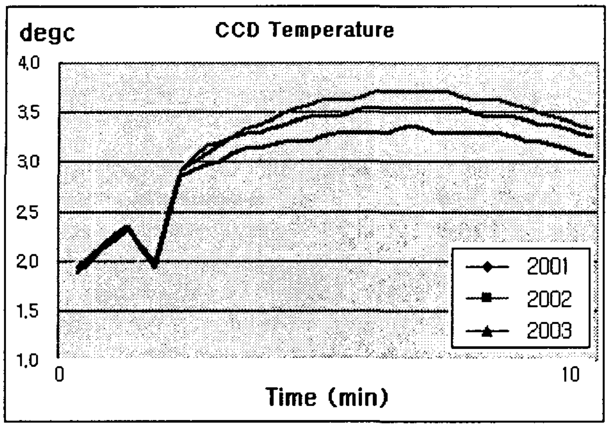

Figure 4. Compare to yearly

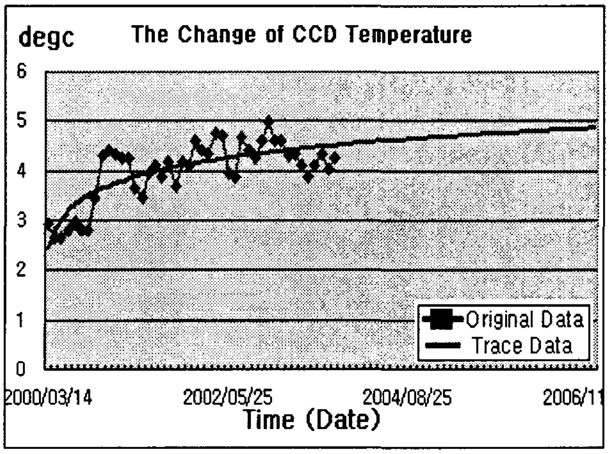

Figure 5. The change of CCD Temperature

Figure 4 is to express the change of the CCD temperature among 14 temperature sensors. The CCD is utilized at the image detection so that change of temperature is observed carefully and is satisfied requirement and can confirm the 0.5℃ increases compared with launch and 2002.

Figure 5 is to express the trace of the CCD temperature. The trace is used a temperature change during the mission period and is expressed to change temperature by 2006 years. The CCD Temperature is satisfied a requirement range until 2006 and The OSMI can get the image to the stability by 2006.

5.0 CONCLUSIONS

The KOMPSAT EOC instrument was designed to perform high resolution data of the Korean Peninsula monitoring in the 510nm to 730nm spectral range. The instrument has a 15km ground swath at altitude of 685km with sun synchronous orbit. The satellite was launched on December 22 1999. On-orbit checkout and characterization of the EOC instrument was performed during LEOP, about 3 month after launch. The EOC image data designed to have the mission lifetime of at least 3 years was distributed from the early of 2000.

In this paper, the status of EOC such as dark calibration, temperature is checked validated through Telemetry during the mission life time of 3 years. The extended operation beyond mission life is confirmed by the analyzed result.

The status of EOC through the data analysis will periodically be checked and confirmed.

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