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Control and Operation of SOXS High Energy Detector

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Abstract. The control and operation of the SOXS High Energy Detector (HED) experiment is done using a micro-processor based data handling system (the GSAT-2 SOXS High Energy Electronics package – GXHE). The GXHE system is used for on-board data analysis, data compression and satellite interfaces for telemetry, telecommand and on-board power.

Keywords : Solar flares - X-ray detectors.

1. SOXS High Energy Experiment

The High-Energy experiment of Solar X-ray Spectrometer (SOXS) consists of an electronics package (GXHE) that collects data from the Detector package (GXHD) described elsewhere (Malkar et al., this conference). GXHD contains the actual detector (NaI/CsI scintillators in Phoswich configuration viewed by a photomultiplier tube) and all associated front-end electronics while GXHE contains a microprocessor (80C86) based processing electronics responsible for onboard data management and communication with ground station. The Phoswich detector has energy range of 20 keV - 10 MeV which is covered by three different amplifiers G1, G2 and G3 of decreasing gains covering, 20 - 270 keV, 270 keV - 2 MeV and 2 - 10 MeV respectively. Events from the G1 amplifier are further subdivided into G1 (NaI) - occurred in NaI(Tl) crystal and G1(CsI) - occurred in CsI(Na) crystal. For each X-ray event detected, the detector box sends 3 bytes of data which contain amplifier identification, pulse height or energy information and pulse shape or the origin (NaI or CsI) of the event. The main job of the processing box is to analyze this information and store/transmit the data. Additionally, for each X-ray event pulses corresponding to different energy ranges are hardware counted and sampled at the rate of 1.4 s.

1.1 Control and operation

There are 5 signals to control the detector which include facility to change high voltage, thresholds etc. Output from a Voltage Controlled Oscillator (VCO) is also available from the detector to monitor house keeping parameters. The communication to the satellite is through a common electronics module (GXCE) which involves power, tele-command (7 pulse commands and one 16-bit data command), Low Bit rate satellite Telemetry (LBT) and a High Bit rate Telemetry (HBT) dedicated to the SOXS experiment. On-Board Time (OBT) is measured through a clock in the satellite telemetry. Absolute time can be measured to an accuracy of 8 ms and relative time (using the processor clock) can be measured to an accuracy of a fraction of ms.

GXHE has 1 MB memory for onboard data storage. During daytime operation, the HBT line will be used by SOXS Low Energy Detector Experiment. Hence SOXS HED will have to store data onboard and transmit it at the end of the day. During nighttime operation, the HBT line will be available for the HED. Six different modes are designed for the complete operation of this experiment. For daytime operation i) Solar quiet mode, ii) Solar flare mode & iii) Flare spectral mode are used whereas for nighttime operation iv) Debug mode & v) Pulsar mode are used. A sixth mode called secondary spectral mode stores low time resolution spectral and housekeeping data in all the above modes.

In Debug Mode the complete raw data received from the detector box is transmitted with full telemetry. It will be useful during the verification phase. During night operation Pulsar Mode is used to send event wise data with full time resolution (0.3 ms). Only G1 (NaI) events will be sent to minimize background. However, spectra from other amplifiers will also be sent every 8 seconds. All the daytime operation modes will be binned modes with events occurring during given time interval and given energy range added together. One second binning in 4 different channels as well as 64 channel spectrum every 100 s will be stored during solar quiet time. During the flare time, both timings will be reduced by factor of 10. However, there are some very large flares, during which count rate is sufficiently high to provide higher spectral resolution at every 0.1 s. For such large flares 3 channel spectra will be accumulated every 0.1 s. There will be two different trigger thresholds for small and large flares. In the quiet mode, flare search will be carried out at 0.1 s time resolution. There will be eight different criteria to check for flare detection. If the count rate in each criterion exceeds the threshold consecutively for 0.5 seconds flare detection will be reported. All the threshold values can be changed by command.

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