

FRONT-END TELEMETRY DATA ACQUISITION UNIT FOR KSLV-I UPPER STAGE

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ABSTRACT

Upper stage telemetry system of KSLV-I (Korea Space Launch Vehicle I) is composed of MDU (Master Data Unit), RDU (Remote Data Unit), SRU (Shock Recorder Unit) and Transmitter. RDU is the front-end telemetry data acquisition unit which gathers analog/discrete signals from various sensors and other units, and transmits the processed data to MDU via MIL-STD-1553B data bus. In order to acquire useful data from analog signal, signal conditioning circuits, such as anti-aliasing or amplifying, should be implemented. For this purpose, SCM (Signal Conditioning Module) had been developed. This paper describes hardware structure of SCM and analog signal conditioning circuits for various sensors. Also, sampling time scheme for different sampling rates were designed and tested.

Keywords: telemetry, signal conditioning module, data acquisition, KSLV-I

1. INTRODUCTION

RDU is the front-end telemetry data acquisition unit for upper stage of KSLV-I. It is capable of gathering up to 128 differential analog channels and 16 discrete channels from various sensors and other units in every 10ms, and transmits the processed data to MDU via MIL-STD-1553B data bus. Previously, processing part of RDU has been developed and showed its processing capacity to meet the requirements (Jung et al. 2003).

2. SIGNAL CONDITIONING MODULE

In order to acquire the useful data from analog sensor signal, RDU needs to provide signal conditioning circuitry which contains anti-aliasing filters, instrument amplifiers, and excitation power.

For this purpose, we have been developed the prototype model of RDU with SCM (Signal Conditioning Module, Fig.1). SCM is composed of various types of SCAs (Signal Conditioning AMP, Figure 2). SCA is a modular PCB with metallic housing which reduces size of back-plane PCB. Also, it makes easier to replace in case of single point failure. Table 1. shows the types of sensors and properties of the SCAs in signal conditioning and Figure 3 shows block diagram of RDU.

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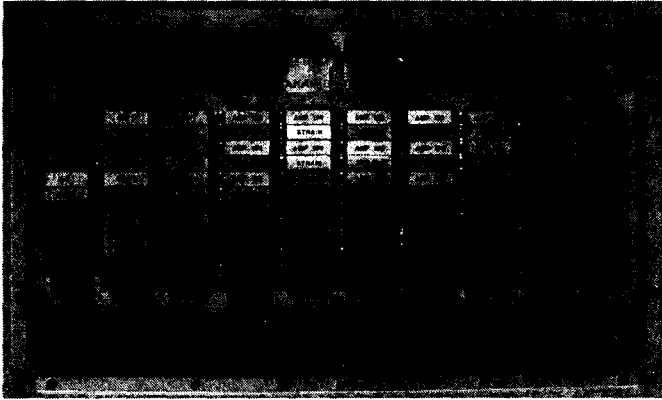


Figure 1. Photo of signal conditioning module.

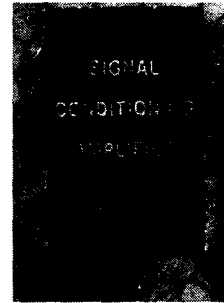


Figure 2. SCA.

Table 1. Types of sensors and properties of SCAs.

| Sensors | # of channels | Properties of SCAs |
|--------------|---------------|--|
| Strain gauge | 21 | 350 Ω Bridge, Voltage Reference, Amp gain 100 |
| RTD* | 62 | 100 Ω Bridge, Voltage Reference, Amp gain 5 |
| Pressure | 6 | Amp gain 1 |
| Vibration | 4 | Low Pass Filter, Voltage Reference, Amp gain 50 |
| Displacement | 6 | Amp gain 1 |
| ETC | 13 | Amp gain 1 |

RDU employs a micro-controller, especially 87C196KD, which contains an ADC ranging from 0V to 5 V. Except some channels which do not need voltage references, other channels are biased to +2.5 V. Strain gauge is measured via a 350 Ω Wheatstone bridge with 10V excitation voltage and X100 instrumentation amp. RTD uses a 100 Ω Wheatstone bridge with 5 V excitation voltage and X5 instrumentation amp. Piezo-electric type vibration sensor needs a constant current source and a low pass filter located in front of the instrumentation amp. There are 13 buffer channels for pressure, displacement sensors and status health monitoring of other on-board sub-units.

Conditioned signals are selected by eight 16X1 analog MUXs and converted into digital by the micro-controller which contains 8X1 MUX. After completion of the AD conversion, the data is stored in the message buffer of MIL-STD-1553B controller which is operated as an RT (Remote Terminal) on the MIL-STD-1553B bus.

Discrete signals are, firstly, latched on two octal latches. When the address-encoded latch-output-enable signal is asserted, latched data are stored in the 1553B message buffer.

3. SAMPLING TIMING

RDU is developed to acquire analog signal with various sampling rate. As shown in Table 2, RDU is implemented to have 10, 100, 200, and 400 Hz sampling rate. As depicted in Table 2, total number of channel is 184.

One major message frame comprises 10 minor frames which run at 100 Hz. Therefore, one minor frame contains four 400Hz channels, twelve 200 Hz channels, seventeen 100 Hz channels, and sixteen 10Hz channels. A datum size is one byte (8 bits) and one minor frame is comprised

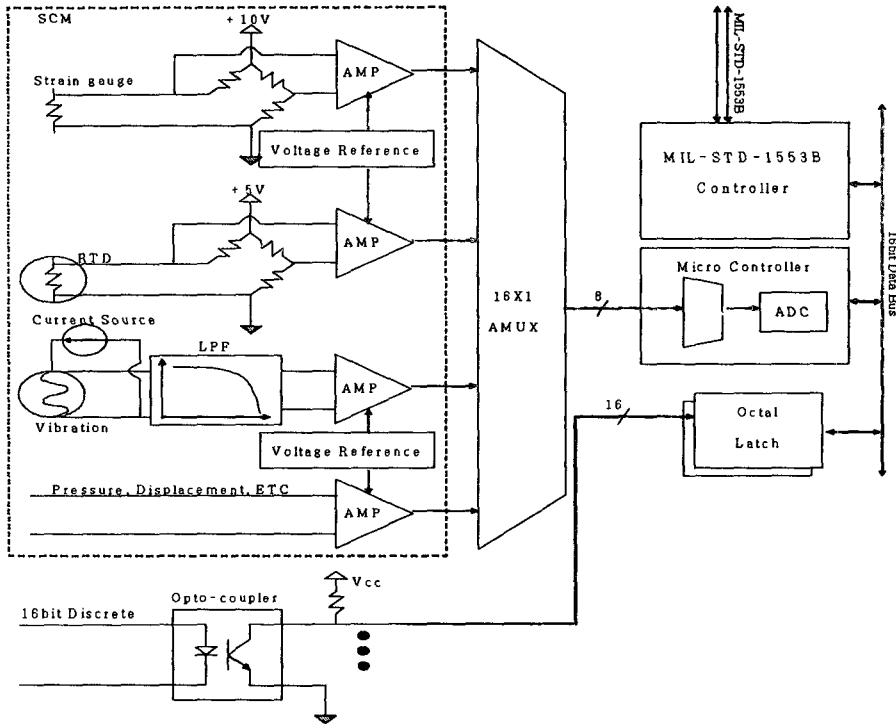


Figure 3. Block diagram of RDU.

Table 2. Number of channels and sampling time results for each sampling rate.

| Sampling rate | 10 Hz | 100 Hz | 200 Hz | 400 Hz |
|-------------------|-------|--------|--------|--------|
| # of channels | 160 | 17 | 6 | 1 |
| Offset (μ s) | | 3700 | 1200 | 0 |
| Length (μ s) | | 462 | 110 | 22 |
| Period (ms) | | 10 | 5 | 2.5 |

of 24 words (or 48 bytes). To provide various sampling rate, RDU utilizes 3 software timers in the micro controller.

Figure 4 illustrates test results of sampling duration and period with regard to each sample group. By toggling each I/O port bit at the start and end of the each group-sampling operation, the sampling duration and period were measured. Result values are attached in Table 2. Total sampling duration of each group in one minor frame is about 770μ s. Because RDU has 90% throughput margin, RDU is able to handle quite more additional sensor signals.

4. CONCLUSIONS

In developing front-end telemetry data acquisition unit of upper stage KSLV-I, signal conditioning module has been designed and made to acquire analog signals from various sensors and other on-board units. Strain gauge, RTD, and piezo-electric type vibration sensor signal conditioning circuits were fabricated into modular SCAs. Adoption of SCA module contributes to minimize

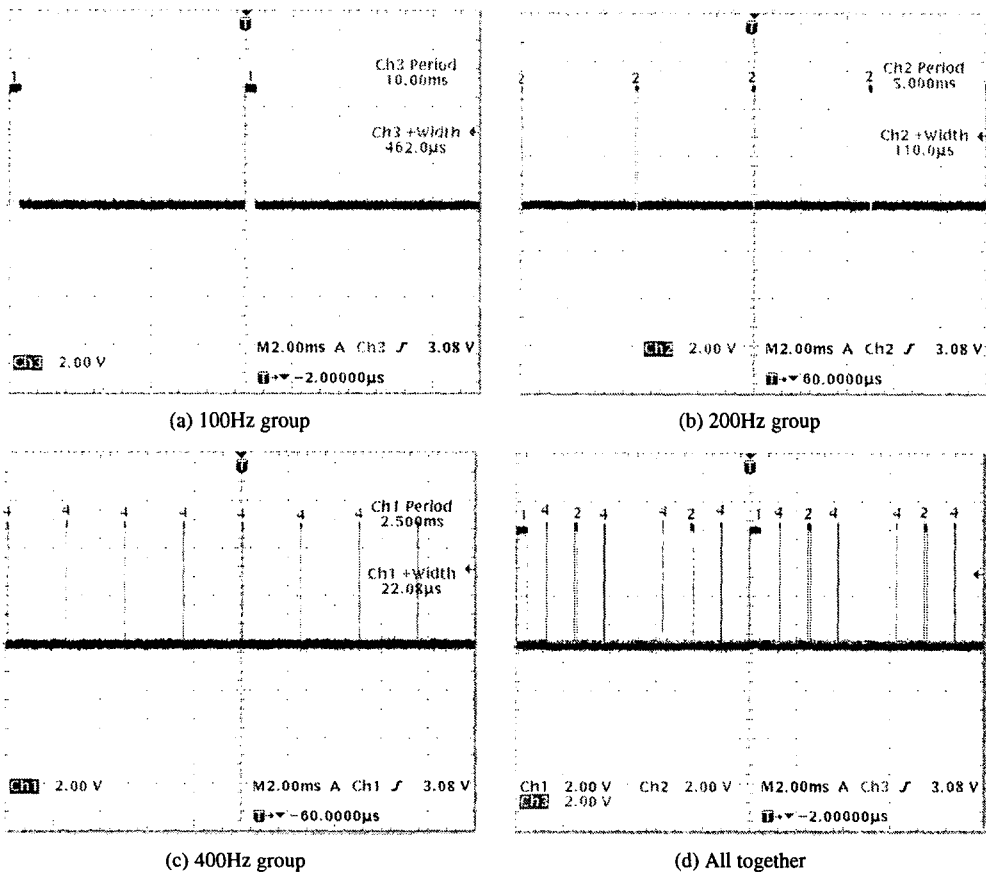


Figure 4. Time length and period of each sample group.

back-plane PCB and makes it easier to replace in case of single point failure. Every channel was divided into 4 groups based on sampling rate and had given it's own offset time to prevent overlapping sample duration. The whole channel assignment for upper stage of KSLV-I is not decided yet and there are many possibilities that total channel number will exceed current requirements. But, test result showed that RDU meets the current requirements and is also able to handle quite more additional sensor signals.

REFERENCES

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