A Low-power Large-capacity Storage Method for Deep-sea In-situ Radiation Measurement

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1. Introduction

Deep-sea in situ radiation detection equipment is one important section of deep-sea and hadal intelligent technology and seafloor science laboratory, aiming at monitoring and assessment of nuclear radiation in deep-sea environment. It is designed to work at the deep seafloor for half a year. During the working period, the equipment will generate large volume of data. Besides, this equipment is powered by batteries. So design challenge of large capacity storage with low power is met in the equipment development. However, the progress in the low power deep-sea detection equipment research is relatively slow due to the special environment of the deep sea. Public researches about low power large-capacity storage methods about deep-sea detection equipment are few. This paper proposes a low-power large-capacity storage solution based on the combination of static random-access memory (SRAM) and embedded multi-media card (eMMC) Flash.

2. Methods

Main structure of low power large-capacity storage method is shown in shown in Figure 1. Foremost, two 128 GB eMMC Flash chips are selected as the main large-capacity storage. The maximum total data volume is respected to be about 200 GB during the sub-sea working period. eMMC Flash is currently the most popular local large-capacity storage solution because of the characteristic advantage of the integration of a controller, a standard MMC interface and Nand Flash, which simplifies the design of storage. However, if the eMMC Flash keeps running, its high power consumption will reach to about several hundred milliwatts, which will shorten the batteries' lifespan. In order to reduce the power consumption, a storage method combining SRAM and Flash is designed. During every data recording cycle, data is first buffered into the SRAM chip meanwhile the Flash keeps in sleep mode. Then Flash is wakened up and data is written to Flash from SRAM when the SRAM is almost full. In this way, Flash almost stays in sleep mode most of the time except for the data transfer period. Furthermore, a low-power FPGA of Microsemi's IGLOO2 series based on Flash technology is adopted as the control center of the circuit to further reduce the power consumption.

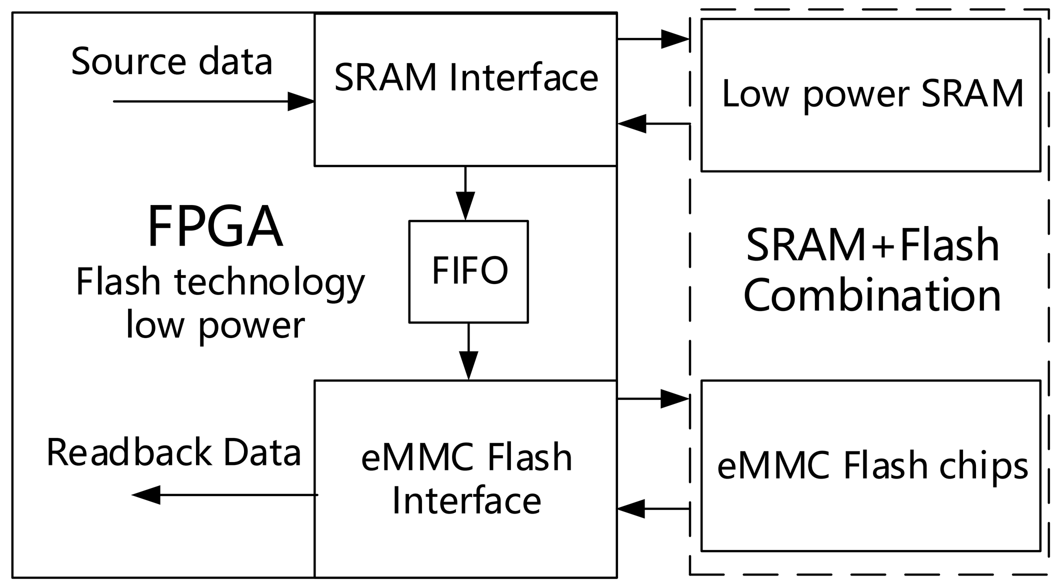

Figure 1 Main structure of power large-capacity storage method

3. Results

Tests were carried out to validate the power consumption reduction. The prototype circuit has been produced shown in Figure 2. The test logic for comparison the power consumption in two working mode was designed, and the structure of test logic is shown in Figure 3. There are two data stream paths for power consumption comparison in in Figure 3. For one data stream path, generated data is directly written to eMMC Flash chip through eMMC logic interface. For another data stream path, generated data is stored using the method proposed in this paper. Digital power device is used for power consumption observation. Test result showed that the power consumption based on the combination of SRAM and Flash was 180mW lower than that using Flash alone. Furthermore, the protocol circuit adopted IGLOO2 series FPGA based on Flash technology as control center. According to Microsemi's official data the IGLOO2 series FPGA has 3x lower static power, 5x lower transceiver power and 25% lower total power than competing SRAM FPGAs.

Figure 2 Test protocol circuit

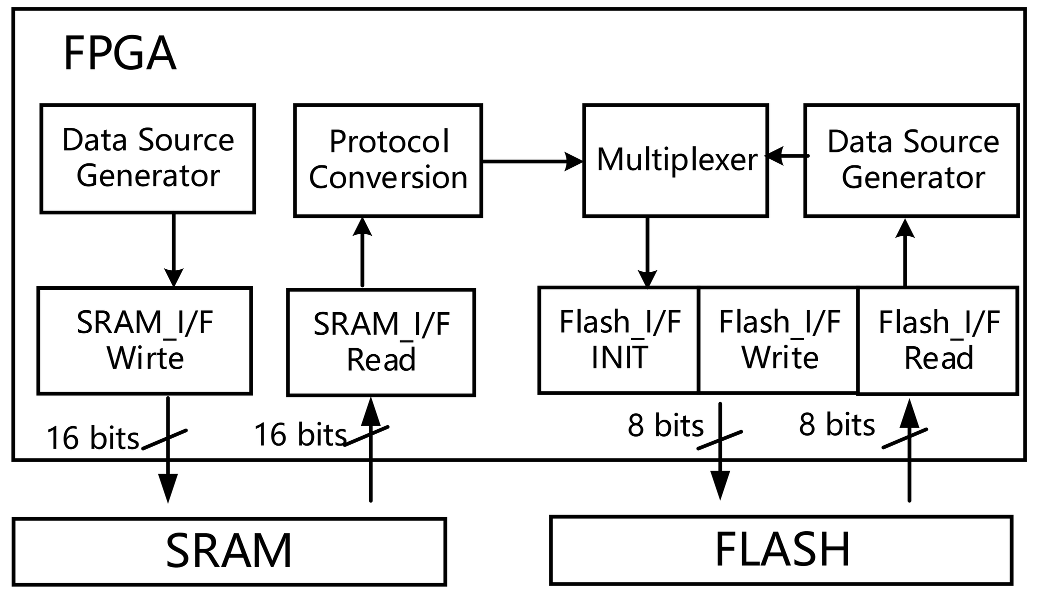

Figure 3 structure of test logic

4. Conclusion

Design challenge of large capacity storage with low power is met in the development of deep-sea in situ radiation detection equipment. This paper proposes a low-power large-capacity storage solution based on the combination of SRAM and eMMC Flash. Test result showed that Preliminary estimation shows that this storage solution reduces power consumption by more than 90% compared to the way Flash working alone. The estimated total power consumption can reach down to 6.6 mW. The proposed storage solution significantly reduces power consumption and satisfies the long time running requirements for the deep-sea in-situ equipment.

5. Acknowledgement

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