Design of 1394B Acquisition Link Fault Auto Recovery System

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Abstract. In flight test , it is very important part that 1394B data acquisition in flight test system to acquire flight test data. With the increasing complexity of airborne electromagnetic environment, 1394B acquisition link fault because of unknown interference, to cause trouble on 1394B acquisition data update. This will directly affect the safety monitoring of flight test. Based on this problem, a design scheme of fault auto repair presented to analyse data of the 1394B heartbeat on real time by means of embedded computing board. When the data is found not to be updated to restart the power in order to re-establish the 1394B link. This will be the data returned to normal.

Keywords: 1394B Bus, Fault Repair, Real-time Computation, 1394B Link, Auto Recovery

1 Introduction

In the flight test, in order to assess the performance and index of the aircraft, the test flight test system often needs to collect the on-board 1394B bus data. 1394B bus data contains important flight test data, which is the data basis for the identification of the aircraft. As the complexity of the airborne electromagnetic environment increases, the test flight test system is also more and more subject to a variety of electromagnetic interference, a variety of instantaneous power spikes, which in severe cases will directly lead to the malfunction of some of the test equipment. In order to avoid the impact of the test flight test system on the airborne 1394B bus system, the 1394B bus acquisition link needs to design a complex isolation circuit system. Due to the many intermediate conversion links, the anti-interference capability of the 1394B bus acquisition link is reduced. In the complex electromagnetic environment, the 1394B bus acquisition link will be broken by chance, causing the 1394B bus acquisition data to stop updating. This seriously affects the safety monitoring of flight test. Based on this, this paper proposes a design scheme of 1394B bus acquisition link failure

automatic repair system, which can monitor the 1394B bus data status in real time, and can automatically identify the failure phenomenon of 1394B acquisition link breakage, and start the link repair system to re-establish the 1394B bus link, so that the data can be restored to normal, and ensure the continuity of the 1394B bus acquisition data.

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2 Program design

The design scheme of the 1394B bus acquisition link fault automatic repair system is shown in Fig. 1. 1394B bus signals are sent to the 1394B bus acquisition board through the acquisition front-end. 1394B bus acquisition board will meet the requirements of the general

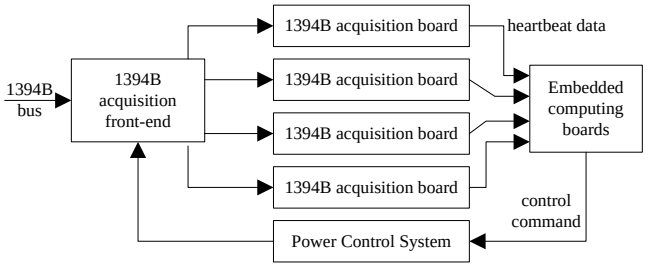

Figure 1 Basic principle of the system program

Line data is captured for real-time recording or telemetry transmission for test flights, and the embedded computing board will capture the heartbeat data captured by the 1394B bus acquisition board in real time and analyze the heartbeat data in real time. The heartbeat data of the 1394B bus is an important data that characterizes the transmission of the bus data, and it is updated in real time in accordance with the frequency of the bus transmission, and the heartbeat of the 1394B bus will be stopped when there is an abnormality in the 1394B bus link. Updating. Therefore, the system can use the 1394B bus heartbeat data as the basis for judging the status of the 1394B bus acquisition system. When the embedded computing board finds that all the heartbeat data in the bus stops updating, it can judge that the 1394B bus acquisition link is broken, and the embedded computing board will send control commands to the power control system to restart the 1394B bus acquisition front-end, re-establish the 1394B bus acquisition link, and resume data acquisition until the heartbeat data is normal. This approach can effectively ensure the continuity of the 1394B bus acquisition data, to avoid the problem of data not updated due to the 1394B bus broken chain [1-4].

3 Hardware realization scheme

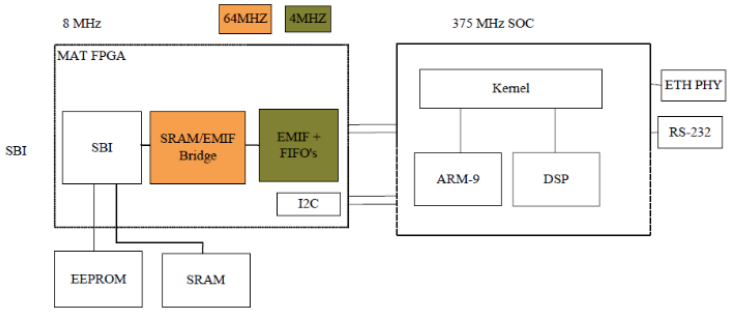

Fig. 2 Design scheme of embedded computing boards

KAM4000 collector is an acquisition system developed by CURTISS-WRIGHT, in which the 1394B bus acquisition board FBM/105 is a kind of acquisition board specializing in the on-board 1394B bus, which can realize the data acquisition function of the on-board 1394B bus. Embedded computing board MAT101 is the basic module of KAM4000 collector. The module is built with DSP and ARM as core devices, as shown in Figure 2. Users only need to design the embedded software running on the DSP and ARM processor, you can complete the parameters collected by the collector to carry out logical judgment, mathematical operations and other complex operations. MAT101 can capture the heartbeat data of the 1394B bus on the collector's base board in real time, and analyze the heartbeat data in real time, and when it is found that the heartbeat stops updating all the time, through the MAT101 module's When it is found that all the heartbeats stop updating, a command level signal is issued through the RS232 interface of the MAT101 module, and the power supply control system restarts the power supply of the front-end of the 1394B bus acquisition after receiving the command signal.

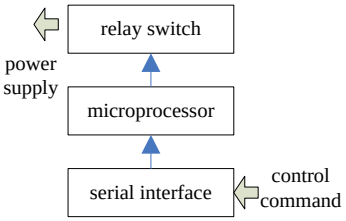

Fig. 3 Design principle of power control system

The design scheme of the power control system is shown in Figure 3. The power control system is mainly composed of relay switches, microprocessor, the microprocessor receives the control signals coming to the embedded computing board through its serial interface, and when it receives the command to restart the power supply, it restarts the power supply of the front-end of the 1394B bus acquisition through the relay switches, so as to re-establish the link of the 1394B bus acquisition link [5-6].

4 Embedded software development

Embedded computing board MAT101 main function is to determine whether the 1394B bus acquisition link is normal.MAT101 module hardware structure to DSP6000 and ARM9 as the core, the bottom running Linux operating system. Using the open source Oracle VirtualBox virtual machine, in windows to simulate the development environment of Linux, the design of the DSP program, the program flow is shown in Figure 4. At the beginning of the program, MAT101 captures the captured 1394B bus data in real time and analyzes whether the bus data stops updating or not, and when it is found that the data stops updating, it sends a restart power command through the serial port to restore the link to normal. Finally, the program recaptures the 1394B bus data for the next real-time judgment.

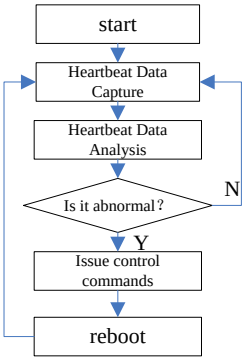

Figure 4 Embedded program flow

DSP program is the core of MAT101, is to complete the bus data processing execution code, through the TI company comes with a compiler for compilation, compilation results with the Ubuntu operating system software together in the virtual machine for the synthesis of the formation of the program Zip file for MAT101 loaded. The file package in the collector configuration software DAS Studio 3 to compile and synthesize again, and finally form the collector's programming files, loaded through the network port into the KAM4000 collector[7-11].

5 Experiment

In order to verify whether the function of the 1394B bus acquisition link fault automatic repair system meets the application requirements, it is necessary to fault injection of the 1394B bus system. Normal 1394B bus heartbeat shown in Figure 5, point A for the heartbeat value of 32-bit counter overflow from 65535 jump to 0; fault injection after the 1394B heartbeat shown in Figure 6, the heartbeat no longer occurs at the point B incremental, working abnormally; after the fault automatic repair 1394B bus heartbeat as shown in Figure 7, the heartbeat will no longer be incremental at point C to incremental value, the system returns to normal. This shows that the 1394B bus acquisition link fault automatic repair system design can better solve the 1394B bus heartbeat data stop updating the fault problem.

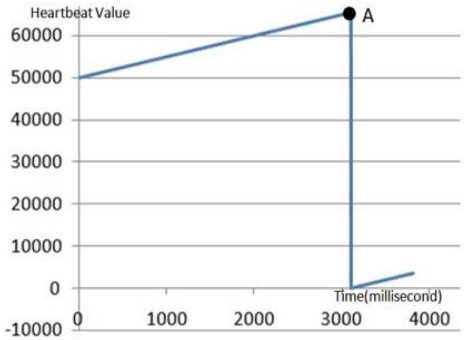

Figure 5 Normal 1394B bus heartbeat

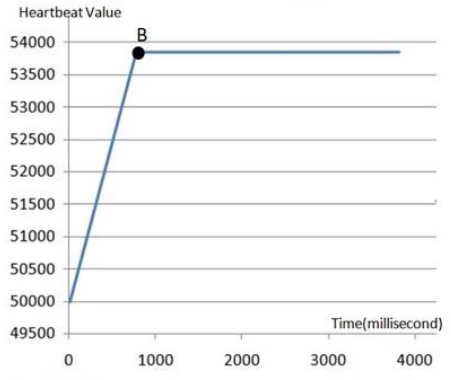

Figure 6 1394B bus heartbeat after fault injection

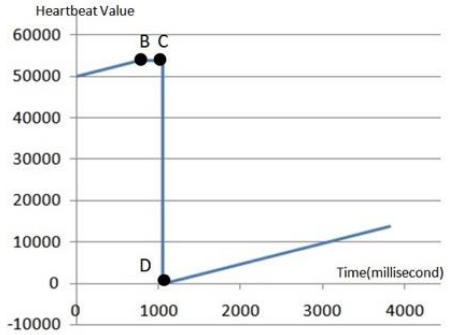

Figure 7 Heartbeat data for automatic fault repair

6 Summary

Aiming at the problem of occasional broken link failure of 1394B bus acquisition link due to electromagnetic interference in the flight test, this paper puts forward a design scheme of automatic fault repair system, discusses in detail the basic principle of such a scheme and the hardware system implementation scheme, and carries out the flow design of the embedded software program. Finally, the feasibility of this scheme is verified through experiments, which can solve the problem of 1394B bus acquisition link failure to restart the power supply to realize the automatic repair function of the fault phenomenon.

References

[1] Don Anderson; translated by Jiang Hanlong. FireWire System Architecture[M] . Beijing:China Electric Power Press,2001.

[2] Texas Instruments. TSB12LV01B IEEE1394 Link2Layer Controller data manual [Z].Texas :Texas Instruments ,2000.

[3] Texas Instruments, 2000. IEEE1394 protocol and interface design [M]. Xi'an: Xi'an University of Electronic Science and Technology Press, 2004.
[4] Chen Feng. Principles and System Design of Blackfin Series DSP[M]. Beijing: Electronic Industry Press, 2004.
[5] Zhang D. IEEE1394 Protocol and Interface Design[M]. Xi'an: Xi'an University of Electronic Science and Technology Press, 2004.
[6] IEEE standard for a high performance serial bus (IEEE Std.1394-1995)[S].Institute of Electrical and Electronics Engineers,1995.
[7] Zhan Peng. FPGA implementation of aviation high-speed bus protocol AS5643[J]. Telecommunication Technology,2013,8:017.
[8] FENG Sha,LU Xuan-Xuan,WANG Xing-liang. A driver design based on SAE AS5643 bus protocol[J]. Measurement and Control Technology,2013,31(10):98-100.
[9] LIU Sha, YIN Yafang.1394B bus system driver software design under VxWorks[J]. Measurement and Control Technology,2013,(5):96-99.
[10] Niu Shiqi, Yan Shengang, Ren Xianglong.Research on the realization scheme of AFDX terminal system[J]. Computer Measurement and Control, 2009, 17 (12) :2507~2509.
[11] Li Liang. Introduction to Avionics Full-Duplex Switched Ethernet-AFDX[J]. Aircraft Engineering, 2006 (3) :48~50.