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Space data and information transfer systems - 1553B data bus communication protocol on spacecraft

空间数据与信息传输系统 航天器1553B总线通信协议

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1 Scope

The document describes the bus topology, the usage conventions, the bus communication mechanisms, the bus communication processes, the reliability design and the management information base of 1553B bus communication as applied on spacecraft.

It applies to the development of the equipment and systems that use the 1553B bus on spacecraft and of the matching ground test equipment.

2 Normative references

One normative reference is listed: GB/T 42041, Astronautics terminology - Space data and information transfer. For dated references only the edition corresponding to that date applies; for undated references the latest edition, including all amendments, applies.

3 Terms and definitions

The terms and definitions given in GB/T 42041 and the following ones apply to the document.

3.1 1553B data bus: a digital, time-division command/response type multiplex data bus.

3.2 terminal: the electronic assembly that connects the data bus to an application device. Note 1: on the 1553B bus there are three kinds - bus controller, bus monitor and remote terminal. Note 2: a terminal may exist as a separate replaceable assembly or may be contained inside the application device.

3.3 bus controller (BC): the terminal that organizes information transfer on the 1553B bus.

3.4 bus monitor (BM): the terminal that receives and records the messages transmitted on the 1553B bus and is able to extract information selectively. Note: if it is assigned a terminal address and takes part in communication, it is called a monitor terminal (MT).

3.5 remote terminal (RT): every terminal on the 1553B bus that takes part in communication without acting as bus controller or bus monitor.

3.6 word: the basic data unit of 1553B bus communication. Note 1: a word is made up of 20 bit, comprising a 3 bit synchronization header, 16 bit of data and 1 bit of odd/even parity; the 3 bit synchronization and the 1 bit check serve the physical layer, and the word that carries the information is the 16 bit of data. Note 2: there are three types of word - command word, status word and data word.

3.7 message: the basic unit of the data transferred on the bus. Note: it includes the command word, the status word, from 0 to 32 data words and the status response intervals, within one transmission sequence.

3.8 message frame: a message sequence made up of several messages. Note: the bus controller arranges the order of the bus communication messages by organizing message frames.

3.9 mode code: the class of message by which the bus controller manages the information flow of the bus system and the associated hardware, and which is not used for data transfer.

3.10 broadcast: a manner of bus communication in which a message sent by one terminal can be received by several other terminals or by all terminals.

3.11 redundant bus: a data transfer path that uses more than one bus between terminals.

3.12 distribution: the process by which the bus controller sends out a message.

3.13 acquisition: the process in which the bus controller organizes a remote terminal to send out a message and other remote terminals or the bus controller act as the receiving side of that message.

3.14 set data: the operation by which an application taking part in bus communication hands the data to be sent over to the terminal for transmission.

3.15 get data: the operation by which an application taking part in bus communication extracts the received data from the terminal.

4 Abbreviated terms

The abbreviations used in the document are BC for bus controller, BCA for BC application, BM for bus monitor, OSI for open system interconnect, RT for remote terminal and RTA for RT application.

5 General principles

5.1 Protocol layers and content. Figure 1 shows how the 1553B bus communication protocol specified in the document corresponds to the OSI layered protocol. The 1553B bus communication layers on a spacecraft cover the physical layer, the data link layer and the protocol of the interface towards the application layer. From the application point of view the document mainly specifies how the 1553B bus link layer protocol is used; it corresponds to part of the content of the link protocol sublayer and to part of the interface content at the lower end of the application layer, chiefly the bus topology, the subaddress conventions, the selection of mode code messages, the bus communication mechanisms and the bus communication processes. These serve the arrangement of messages and the exchange of data during 1553B bus communication, keep bus communication stable and reliable, and support the drawing up of specific mission protocols at the upper layer.

5.2 Bus topology. A 1553B bus system consists of one BC and of 1 to 31 RT (addresses 0 to 30); a BM may be configured as required. The topology is shown in Figure 2. The BC and the other terminals form a master-slave communication relationship and are connected by bus cables. Dual redundant bus cabling is normally configured, and multiple redundant cabling may be configured according to need and importance; the cables back each other

up and a bus communication message may be transmitted over any one of them. Every terminal has a corresponding service application object, which may belong to the same device as the terminal or may be a replaceable assembly outside that device. The BM mainly monitors the state of bus communication and hands the monitored data over to the BM application for processing; it can also take part in normal communication by being assigned a terminal address, in which case it is called a monitor terminal (MT). The BM can act as a backup of the BC: when it monitors abnormal BC operation it can switch to BC mode and work in place of the BC. The switchover can be carried out automatically by some mechanism or through an external command; when switching over, the BC working mode of the BC is normally stopped first and the BM is then switched to BC working mode, so that two BC do not work on the bus at the same time. There are 32 RT addresses, of which 0 to 30 (binary 0 to 11110) are the exclusive addresses of the RT and 31 (binary 11111) is used for broadcast; in practice 0 should as far as possible not be used as the exclusive address of an RT.

5.3 Subaddress conventions. Each RT has 32 transmit subaddresses and 32 receive subaddresses, used to distinguish the sending and receiving of different kinds of data message. The use of the RT subaddresses is fixed in Table 1, and the explanation of the definitions together with the recommendations for use are given in A.3. Table 1 has four columns - subaddress, RT transmit, RT receive and remarks - and reads as follows. Subaddress 0 is not used. Subaddresses 1 to 26 carry acquire data on transmit and distribute data on receive; the kinds of message may be defined according to the needs of the mission, and they serve the send and receive processes (7.4, 7.5) as well as data block transfer (A.5). Subaddress 27 carries the distribution transfer acknowledgement on transmit and the distribution transfer description on receive, for the handshake send process between the sending and the receiving side (7.4). Subaddress 28 carries the acquisition transfer request on transmit and the acquisition transfer acknowledgement on receive, for the handshake receive process between the sending and the receiving side (7.5). Subaddress 29 carries the time code on transmit and the time code on receive, where the receive direction may also be broadcast; it serves the time distribution process (7.8). Subaddress 30 carries the long loop-back test in both directions, for the long loop-back test process (6.5.1, 7.9.1). Subaddress 31 carries the mode code in both directions, whose use is agreed in 5.4.

5.4 Conventions for the use of mode code messages. The 1553B bus defines 15 kinds of mode code message; the document fixes the way the following five commonly used mode code messages are used and lays down no usage convention for the remaining ten. a) Synchronize (binary code 00001): without data word, broadcast or non-broadcast; used to notify the relevant RT of a predetermined event so that the RT synchronizes; the synchronization process is given in 6.3 and 7.7 and the time distribution process in 6.4 and 7.8. b) Initiate self-test (binary code 00011): without data word, non-broadcast; used to start the test circuit inside the RT; the test process is given in 6.5.2 and 7.9. c) Transmit vector