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(54) TRAIN CONTROL DMI DATA REDUNDANCY CONTROL METHOD AND SYSTEM

VERFAHREN UND SYSTEM ZUR STEUERUNG DER DMI-DATENREDUNDANZ EINER ZUGSTEUERUNG

PROCÉDÉ ET SYSTÈME DE COMMANDE DE REDONDANCE DE DONNÉES DMI DE COMMANDE DE TRAIN

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Description

TECHNICAL FIELD

[0001] The present invention relates to a field of dual-machine hot standby technology, and more particularly to a train control DMI data redundancy control method and system.

BACKGROUND

[0002] In a field of train communication, a data packet between a Driver Machine Interface (DMI) and a vehicle-mounted main control unit is transmitted via a bus.

[0003] The main control unit as a vehicle-mounted device transmits data to the driver machine interface via the bus; and the driver machine interface also transmits data to the vehicle-mounted main control unit via the bus; wherein, a plurality of corresponding ports may be configured on both the vehicle-mounted main control unit and the driver machine interface as required for interactive data transmission.

[0004] The existing vehicle-mounted device is a single-system main control unit; the main control unit performs interactive data transmission with the driver machine interface via a bus, and does not have a dual-system hot standby function; FIG. 1 shows a schematic diagram of a communicative connection relationship between the driver machine interface and the vehicle-mounted main control unit in a prior art; the driver machine interface reads data sent by the vehicle-mounted main control unit from a corresponding port via the bus; the driver machine interface processes (e.g., unpack) the read data by applying logic; the driver machine interface simultaneously writes data to be transmitted to a corresponding port on the bus; and the vehicle-mounted main control unit reads the data sent by the driver machine interface from a port on the bus for processing.

[0005] Even if the existing vehicle-mounted main control unit has implemented dual-system hot standby, that is, two vehicle-mounted main control units are set up, the two vehicle-mounted main control units respectively serve as a primary system and a standby system, and the two vehicle-mounted main control units are communicatively connected with the driver machine interface, the vehicle-mounted main control units are still in single-system communication with the driver machine interface, that is, a main control unit in use performs interactive data communication with the driver machine interface, while a standby-system main control unit does not carry out data communicative transmission with the driver machine interface at that time; if the main control unit in use fails, the vehicle-mounted device needs to switch to another main control unit, so it is necessary to specifically set up a switching circuit to implement a switching function; and existence of the switching circuit causes reduced switching efficiency and a real-time difference, which is prone to data loss.

[0006] Some prior arts regarding a railway control system can be seen in CN 109720379 A and KR 20130013794 A. CN109720379A discloses a switching display method for a train control DMI. The DMI selects the data to display based on a dual-system hot standby. The selection of information is based on a priority of the information of each of the 4 modules and therefore it is implicit that all data is sent simultaneously to the DMI.

[0007] KR20130013794A discloses a redundant human machine interface device for a railway car. Two independent HMI show information simultaneously to the driver and detect the failure of the other one. In normal operation only the input of the active HMI is enabled. In case there is a failure in the active HMI, its input is disconnected and the input of the standby HMI is activated.

SUMMARY

[0008] The present invention provides a train control DMI data redundancy control method as described in the claim 1, as well as some advantageous embodiments as described in its dependent claims.

[0009] The present invention further proposes a train control DMI data redundancy control system as described in the claim 4, as well as some advantageous embodiments as described in its dependent claims.

[0010] In the train control DMI data redundancy control method and system according to the present invention, the driver machine interface simultaneously receives data sent by a first main control unit and a second main control unit, and respectively uses the first main control unit and the second main control unit as the primary system and the standby system according to a first primary-standby system identifier and a second primary-standby system identifier; when the primary system is abnormal, the first primary-standby system identifier and the second primary-standby system identifier change, and the driver machine interface switches the primary system and the standby system after identifying change of the first primary-standby system identifier and the second primary-standby system identifier, without affecting content displayed by the driver machine interface, and without configuring a switching module, which has a simple structure and high switching efficiency.

[0011] Other features and advantages of the present disclosure will be further explained in the following description, and partly become self-evident therefrom, or be understood through implementation of the present disclosure. The objectives and other advantages of the present disclosure will be achieved through the structure specifically pointed out in the description, claims, and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] In order to clearly illustrate the technical solution of the embodiments of the present invention or in the prior art, the drawings that need to be used in description

of the embodiments or the prior art will be briefly described in the following; it is obvious that the described drawings are only related to some embodiments of the present invention; based on the drawings, those ordinarily skilled in the art can acquire other drawings, without any inventive work.

[0013] Figures 3, 4 and 5 are not according to the invention and are present for illustration purposes only.

FIG. 1 shows a schematic diagram of a communicative connection between a single-system main control unit and a driver machine interface in the prior art;
FIG. 2 shows a schematic diagram of communicative connections of a train control DMI data redundancy control system according to an embodiment of the present invention;
FIG. 3 shows a schematic flow chart of a train control DMI data redundancy control method according to an embodiment of the present disclosure;
FIG. 4 shows a structural schematic diagram a data packet according to the embodiment of the present disclosure; and
FIG. 5 shows a schematic flow chart of a state monitoring process of primary-standby systems according to the embodiment of the present disclosure.

DETAILED DESCRIPTION

[0014] In order to make objectives, technical details and advantages of the embodiments of the present invention apparent, the technical solutions of the embodiment will be described in a clearly and fully understandable way in connection with the drawings related to the embodiments of the present invention.

[0015] A Driver Machine Interface (DMI) is for use of a train driver, to facilitate the driver to drive the train according to displayed information, and to guide the driver to execute related operations according to a prompt.

[0016] This embodiment proposes a train control DMI data redundancy control system, comprising two main control units and a driver machine interface; and in this embodiment, the two main control units are respectively referred to as a first main control unit and a second main control unit;

[0017] One of the first main control unit and the second main control unit serves as a primary system, and the other serves as a standby system;

[0018] The driver machine interface includes a display module and a storage module; the display module and the storage module are not shown; the display module is configured to display data sent by the primary system to the driver machine interface; the storage module is configured to store data sent by the standby system to the driver machine interface; and the data sent by the standby system to the driver machine interface is not displayed. Here, data sent by a main control unit as the primary system is referred to as primary system data, and data sent by a main control unit as the standby system is referred to as standby system data.

[0019] In an operating state, the first main control unit and the second main control unit simultaneously send data to the driver machine interface, wherein, the data sent by the main control unit as the primary system is displayed on the display module, while the data sent by the main control unit as the standby system is stored in the storage module; and the driver machine interface simultaneously feeds back data to the first main control unit and the second main control unit.

[0020] Specifically, referring to FIG. 2, the driver machine interface has a sink port and a source port; the first main control unit is provided with a sink port and a source port; and the second main control unit is provided with a sink port and a source port. The sink ports and the source ports as described above are all coupled to a train bus; and the train bus may be a multifunctional vehicle bus, or a wire train bus, etc. The sink port of the driver machine interface is communicatively connected with the source port of the first main control unit and the source port of the second main control unit; the source port of the driver machine interface is communicatively connected with the sink port of the first main control unit and the sink port of the second main control unit. In the operating state, the driver machine interface simultaneously sends data to the first main control unit and the second main control unit through the source port, and the sent data is received through the sink port of the first main control unit and the sink port of the second main control unit; the first main control unit and the second main control unit simultaneously send data to the driver machine interface respectively through their own source ports, and the sent data is received by the sink port of the driver machine interface.

[0021] The first main control unit is provided with a first heartbeat module; the second main control unit is provided with a second heartbeat module; the first heartbeat module is communicatively connected with the driver machine interface through a heartbeat line; and the second heartbeat module is communicatively connected with the driver machine interface through a heartbeat line. The first heartbeat module and the second heartbeat module respectively send first heartbeat data to the driver machine interface, so that the driver machine interface can monitor states of the first main control unit and the second main control unit.

[0022] The first main control unit is provided with a third heartbeat module; and the second main control unit is provided with a fourth heartbeat module. The third heartbeat module is communicatively connected with the second main control unit through a heartbeat line; the fourth heartbeat module is communicatively connected with the first main control unit through a heartbeat line; the third heartbeat module is configured to send second heartbeat data to the second main control unit, so that the second main control unit can monitor a state of the first main control unit; and the fourth heartbeat module is configured to send second heartbeat data to the first main con-

trol unit, so that the first main control unit can monitor a state of the second main control unit.

[0023] This embodiment proposes the train control DMI data redundancy control method, referring to FIG. 3, in an initial state, the first main control unit and the second main control unit send first heartbeat data to the driver machine interface; if the driver machine interface can receive two sets of first heartbeat data of which heartbeat values are not 0 and the heartbeat values are both normal, it indicates that connections of the driver machine interface with the first main control unit and the second main control unit are normal, and subsequent primary-standby system configuration may be performed. If one or two sets of first heartbeat data are abnormal, it indicates that a connection between the driver machine interface and the first main control unit or the second main control unit is abnormal, and a subsequent process is suspended, at which time, an operator needs to check the device.

[0024] The driver machine interface receives in real time first data sent by the first main control unit and second data sent by the second main control unit; both the first data and the second data adopt a data packet in a typical producer/consumer mode, as shown in FIG. 4, a data packet structure includes a primary-standby system identifier, data and a CRC code. In order to distinguish between the first data and the second data, a primary-standby system identifier of a data packet of the first data is referred to as a first primary-standby system identifier; a primary-standby system identifier of a data packet of the second data is referred to as a second primary-standby system identifier; a CRC code of the first data is generated by the first main control unit; and a CRC code of the second data is generated by the second main control unit;

[0025] The driver machine interface receives in real time the first data sent by the first main control unit; the first data has the first primary-standby system identifier; and the driver machine interface parses the first primary-standby system identifier. In this embodiment, a parsing result of the first primary-standby system identifier is represented by 1 or 2; if the parsing result is 1, it indicates that the first main control unit should be used as the primary system at this time; and if the parsing result is 2, it indicates that the first main control unit should be used as the standby system at this time.

[0026] The driver machine interface receives in real time the second data sent by the second main control unit; the second data has the second primary-standby system identifier; the driver machine interface parses the second primary-standby system identifier; if a parsing result of the second primary-standby system identifier is 1, it indicates that the second main control unit should be used as the primary system at this time; and if the parsing result is 2, it indicates that the second main control unit should be used as the standby system at this time.

[0027] At any time, a parsing result of one of the first primary-standby system identifier and the second primary-standby system identifier is 1, and a parsing result of the other is 2, and a case where the primary-standby system identifiers are both 1 or both 2 will never occur, which ensures that one of the first main control unit and the second main control unit is used as the primary system, and the other is used as the standby system in any case.

[0028] The driver machine interface judges in real time whether a primary-standby system identifier of a source of currently displayed data is 1; if it is 1, no adjustment is made; and if it is not 1, the standby system is switched to the primary system.

[0029] Exemplarily, in the initial state, the first main control unit and the second main control unit mutually agree on that the first primary-standby system identifier is 1, and the second primary-standby system identifier is 2. The first main control unit serves as the primary system; the second main control unit serves as the standby system; the driver machine interface displays the data sent by the first main control unit, at which time, the data sent by the first main control unit is just the primary system data, and the driver machine interface stores the data of the second main control unit, but does not display the data of the second main control unit, at which time, the data sent by the second main control unit is just the standby system data; in a case of failure, poor state or blocked communication, etc. of the first main control unit, such that the first main control unit cannot accurately and timely transmit the data to the driver machine interface, at this time, the first primary-standby system identifier is changed to 2, the second primary-standby system identifier is changed to 1, the second main control unit is upgraded to the primary system, and the first main control unit is downgraded to the standby system, at which time, the driver machine interface displays the data of the second main control unit, and the driver machine interface stores but does not display the data of the first main control unit, at which time, the data sent by the second main control unit is just the primary system data, and the data sent by the first main control unit is just the standby system data; information displayed by the driver machine interface is not affected by abnormality of the first main control unit; and at this time, the first main control unit needs to be repaired, and the repaired first main control unit continue to serve as the standby system.

[0030] Through the above-described analysis, it can be known that, regardless of whether the first main control unit serves as the primary system or the second main control unit serves as the primary system, the driver machine interface receives in real time the data transmitted by the primary system, and the driver machine interface will not have the displayed content affected when switching the primary-standby systems; as compared with the technical solution in the prior art that a structure such as a switch needs to be configured, the data redundancy method according to this embodiment does not need an additional hardware structure configured, rendering higher switching efficiency of the primary-standby systems.

[0031] In addition, after monitoring that the first heartbeat data is normal, the driver machine interface sets valid identifiers of the first data and the second data to true; in order to ensure accuracy and integrity of data transmission, the first data and the second data transmitted are checked. In this embodiment, Cyclic Redundancy Check (CRC) is adopted; the CRC code in the rear of the data packet of the first data is calculated by the first main control unit, and the CRC code in the rear of the data packet of the second data is calculated by the second main control unit; when receiving the first data and the second data, the driver machine interface recalculates the CRC code, and compares a calculation result with the actually received CRC code; if the two CRC codes are equal, there is no transmission error; and if the CRC codes are not equal, there is a transmission error.

[0032] The process of generating CRC code is:

1. Assign a 16-bit variable with 0xffff, the variable being referred to as a CRC register.
2. Exclusive OR a first byte of the message with the CRC register, saving the result to the CRC register.
3. Shift the CRC register one bit to the right, zero-filling the Most Significant Bit (MSB).
4. Judge whether the removed bit is 0 or 1; if it is 0, return to step 3; if it is 1, exclusive OR the CRC register with 0xa001, saving the result to the CRC register.
5. Repeat steps 3 and 4 until eight shifts have been completed.
6. Repeat steps 2 to 5 for a next byte.
7. After every byte of the message is calculated, the CRC code is generated; however, it should be noted that, when placing the CRC code into the message, the Most Significant Byte (MSB) and the Least Significant Byte (LSB) need to be reversed.

[0033] If there is no error during transmission of the first data and the second data, then the driver machine interface is respectively connected with the primary-standby systems, and the driver machine interface displays the content transmitted by the primary system; and if there is an error during transmission of the first data or the second data, the data transmission is stopped to check the device.

[0034] The driver machine interface needs to judge in real time whether a state of a current primary system is normal, to ensure that the standby system can be timely upgraded to the primary system when the primary system is abnormal. Referring to FIG. 5, the driver machine interface receives in real time the first heartbeat data sent by the primary system; the driver machine interface judges the state of the primary system based on the first heartbeat data of the primary system, a first heartbeat data state synchronously changing with a primary system data state, and dynamically changes the first primary-standby system identifier and the second primary-standby system identifier based on a judgment result. If the first heartbeat data is normal, the primary-standby systems are maintained in the current state; if the first heartbeat data is abnormal, the first primary-standby system identifier and the second primary-standby system identifier are changed, the standby system is upgraded to the primary system, and the primary system is downgraded to the standby system; at this time, the standby system may send the first heartbeat data to the driver machine interface, or may not send the first heartbeat data; if the standby system sends the first heartbeat data to the driver machine interface, the driver machine interface simultaneously monitors states of the primary-standby systems.

[0035] Exemplarily, in the current state, the first main control unit is the primary system, the second main control unit is the standby system, the first primary-standby system identifier is 1, the second primary-standby system identifier is changed to 2, and the first main control unit regularly sends the first heartbeat data to the driver machine interface. Specifically, the first main control unit sends, in a unit of 100 ms, a local state, including a normal state and an error state; when the driver machine interface receives error information of the first main control unit, or fails to receive the first heartbeat data for 5 consecutive times, the driver machine interface changes the first primary-standby system identifier to 2, and changes the second primary-standby system identifier to 1; after the primary-standby system identifiers are changed, the driver machine interface displays the second data sent by the second main control unit, stores the first data sent by the first main control unit, downgrades the first main control unit to the standby system, and upgrades the second main control unit to the primary system, so as to implement switch between the primary-standby systems.

[0036] In another design mode for monitoring states of the primary-standby systems, the standby system receives in real time the second heartbeat data sent by the primary system, the standby system judges the state of the primary system based on the second heartbeat data, and dynamically changes the first primary-standby system identifier and the second primary-standby system identifier based on a judgment result; if the second heartbeat data is normal, the primary-standby systems are maintained in the current state; if the second heartbeat data is abnormal, the first primary-standby system identifier and the second primary-standby system identifier are changed, the standby system is upgraded to the primary system, and the primary system is downgraded to the standby system.

[0037] Exemplarily, in the current state, the first main control unit is the primary system, the second main control unit is the standby system, the first primary-standby system identifier is 1, the second primary-standby system identifier is changed to 2, and the first main control unit regularly sends the second heartbeat data to the second main control unit. Specifically, the first main control unit sends, in a unit of 100 ms, a local state, including a normal state and an error state; when the second main control

unit receives error information of the first main control unit, or fails to receive the second heartbeat data for 5 consecutive times, the second main control unit feeds back information to the first main control unit, the driver machine interface changes the first primary-standby system identifier to 2, changes the second primary-standby system identifier to 1, downgrades the first main control unit to the standby system, and upgrades the second main control unit to the primary system, so as to implement switch between the primary-standby systems.

[0038] The data redundancy system may simultaneously adopt the above-described two design solutions for monitoring the states of the primary-standby systems, so as to ensure that the abnormal state of the primary system can be timely monitored, so that the primary-standby systems can be switched in time, to further ensure that the content displayed by the driver machine interface is not affected.

[0039] In another design mode, which is not covered by the present invention, the first data and the second data are not set with primary-standby system identifiers; the driver machine interface receives third heartbeat data sent by the primary system; and a third heartbeat data state changes synchronously with the primary system data state;

[0040] The driver machine interface judges whether the third heartbeat data is normal, and executes, based on a judgment result, steps of:

[0041] If the driver machine interface judges that the third heartbeat data is normal, maintaining the primary-standby systems unchanged;

[0042] If the driver machine interface judges that the third heartbeat data is abnormal, changing the primary system data to the standby system data, and changing the standby system data to the primary system data.

[0043] Exemplarily, in the current state, the first main control unit is the primary system, the second main control unit is the standby system, and the first main control unit regularly sends the third heartbeat data to the driver machine interface. Specifically, the first main control unit sends, in a unit of 100 ms, a local state, including a normal state and an error state; when the driver machine interface monitors that the third heartbeat data is abnormal, the driver machine interface no longer displays the data sent by the first main control unit, but instead displays the data sent by the second main control unit, downgrades the first main control unit to the standby system, and upgrades the second main control unit to the primary system, so as to implement switch between the primary-standby systems.

Claims

1. A train control DMI data redundancy control method, wherein,

   the DMI simultaneously receives and processes two sets of data, wherein the two sets of data have a mutual primary-standby relationship; the DMI judges the primary-standby relationship based on a parsing result of the data; **characterized in that**

   the parsing result includes a primary-standby system identifier, the primary-standby system identifier being dynamically changed based on a data state;

   the DMI judges whether the primary-standby system identifier is a primary system identifier or a standby system identifier;

   the DMI displays data having the primary system identifier, and the DMI stores data having the standby system identifier.

2. The train control DMI data redundancy control method according to claim 1, wherein, the primary-standby system identifier being dynamically changed based on a data state, includes:

   receiving, by the DMI, first heartbeat data sent by a primary system, wherein a first heartbeat data state changes synchronously with a primary system data state;

   judging, by the DMI, whether the first heartbeat data is normal, and executing, based on a judgment result, steps of:

   if the DMI judges that the first heartbeat data is normal, maintaining the primary-standby system identifier unchanged;

   if the DMI judges that the first heartbeat data is abnormal, replacing the primary system identifier with the standby system identifier and replacing the standby system identifier with the primary system identifier.

3. The train control DMI data redundancy control method according to claim 1, wherein, the primary-standby system identifier being dynamically changed based on a data state, includes:

   receiving, by the standby system, second heartbeat data sent by the primary system, wherein a second heartbeat data state changes synchronously with the primary system data state;

   judging, by the standby system, whether the second heartbeat data is normal, and executing, based on a judgment result, steps of:

   if the standby system judges that the second heartbeat data is normal, maintaining the primary-standby system identifier unchanged;

   if the standby system judges that the second heartbeat data is abnormal, replacing the primary system identifier with the standby

system identifier and replacing the standby system identifier with the primary system identifier.

4. A train control DMI data redundancy control system, comprising:

two main control units, configured to respectively send data to the DMI, the two sets of data being in a mutual primary-standby relationship; and
the DMI, configured to simultaneously receive and process the two sets of data in a mutual primary-standby relationship, and judge the primary-standby relationship based on a parsing result of the data;
characterized in that
the parsing result includes a primary-standby system identifier, the primary-standby system identifier being dynamically changed based on a data state;
the DMI is configured to judge whether the primary-standby system identifier is a primary system identifier or a standby system identifier;
the DMI is configured to display data having the primary system identifier, and store data having the standby system identifier.

5. The train control DMI data redundancy control system according to claim 4, wherein, the primary-standby system identifier being dynamically changed based on a data state, includes:

the DMI is configured to receive first heartbeat data sent by a main control unit as the primary system, wherein a first heartbeat data state changes synchronously with a primary system data state;
the DMI is configured to judge whether the first heartbeat data is normal, and execute, based on a judgment result, steps of:

if the DMI judges that the first heartbeat data is normal, maintaining the primary-standby system identifier unchanged;
if the DMI judges that the first heartbeat data is abnormal, replacing the primary system identifier with the standby system identifier and replacing the standby system identifier with the primary system identifier.

6. The train control DMI data redundancy control system according to claim 4, wherein, the primary-standby system identifier being dynamically changed based on a data state, includes:

a main control unit as the standby system is configured to receive second heartbeat data sent by a main control unit as the primary system, wherein a second heartbeat data state changes synchronously with the primary system data state;
the standby system is configured to judge whether the second heartbeat data is normal, and execute, based on a judgment result, steps of:

if the standby system judges that the second heartbeat data is normal, maintaining the primary-standby system identifier unchanged;
if the standby system judges that the second heartbeat data is abnormal, replacing the primary system identifier with the standby system identifier and replacing the standby system identifier with the primary system identifier.

Patentansprüche

1. Zugsteuerungs-DMI-Datenredundanzsteuerverfahren, wobei

die DMI gleichzeitig zwei Datensätze empfängt und verarbeitet, wobei die zwei Datensätze eine gegenseitige Primär-Standby-Beziehung aufweisen; wobei die DMI die Primär-Standby-Beziehung basierend auf einem Parsing-Ergebnis der Daten beurteilt; **dadurch gekennzeichnet, dass**
das Parsing-Ergebnis eine Primär-Standby-Systemkennung beinhaltet, wobei die Primär-Standby-Systemkennung basierend auf einem Datenzustand dynamisch geändert wird;
die DMI beurteilt, ob die Primär-Standby-Systemkennung eine Primärsystemkennung oder eine Standby-Systemkennung ist;
die DMI Daten anzeigt, welche die Primärsystemkennung aufweisen, und die DMI Daten speichert, welche die Standby-Systemkennung aufweisen.

2. Zugsteuerungs-DMI-Datenredundanzsteuerverfahren nach Anspruch 1, wobei
die Primär-Standby-Systemkennung, die basierend auf einem Datenzustand dynamisch geändert wird, Folgendes beinhaltet:

Empfangen, durch die DMI, von ersten Herzschlagdaten, die durch ein Primärsystem gesendet werden, wobei sich ein erster Herzschlagdatenzustand synchron mit einem Primärsystemdatenzustand ändert;
Beurteilen, durch die DMI, ob die ersten Herzschlagdaten normal sind, und Ausführen, basie-

rend auf einem Beurteilungsergebnis, der folgenden Schritte:

wenn die DMI beurteilt, dass die ersten Herzschlagdaten normal sind, Beibehalten der Primär-Standby-Systemkennung unverändert;
wenn die DMI beurteilt, dass die ersten Herzschlagdaten anormal sind, Ersetzen der Primärsystemkennung durch die Standby-Systemkennung und Ersetzen der Standby-Systemkennung durch die Primärsystemkennung.

3. Zugsteuerungs-DMI-Datenredundanzsteuerverfahren nach Anspruch 1, wobei
die Primär-Standby-Systemkennung, die basierend auf einem Datenzustand dynamisch geändert wird, Folgendes beinhaltet:

Empfangen, durch das Standby-System, von zweiten Herzschlagdaten, die durch das Primärsystem gesendet werden, wobei sich ein zweiter Herzschlagdatenzustand synchron mit dem Primärsystemdatenzustand ändert;
Beurteilen, durch das Standby-System, ob die zweiten Herzschlagdaten normal sind, und Ausführen, basierend auf einem Beurteilungsergebnis, der folgenden Schritte:

wenn das Standby-System beurteilt, dass die zweiten Herzschlagdaten normal sind, Beibehalten der Primär-Standby-Systemkennung unverändert;
wenn das Standby-System beurteilt, dass die zweiten Herzschlagdaten anormal sind, Ersetzen der Primärsystemkennung durch die Standby-Systemkennung und Ersetzen der Standby-Systemkennung durch die Primärsystemkennung.

4. Zugsteuerungs-DMI-Datenredundanzsteuersystem, umfassend:

zwei Hauptsteuereinheiten, die konfiguriert sind, um jeweils Daten an die DMI zu senden, wobei die zwei Datensätze in einer gegenseitigen Primär-Standby-Beziehung sind; und
die DMI, die konfiguriert ist, um die zwei Datensätze in einer gegenseitigen Primär-Standby-Beziehung gleichzeitig zu empfangen und zu verarbeiten und die Primär-Standby-Beziehung basierend auf einem Parsing-Ergebnis der Daten zu beurteilen; **dadurch gekennzeichnet, dass**
das Parsing-Ergebnis eine Primär-Standby-Systemkennung beinhaltet, wobei die Primär-Standby-Systemkennung basierend auf einem Datenzustand dynamisch geändert wird;
die DMI konfiguriert ist, um zu beurteilen, ob die Primär-Standby-Systemkennung eine Primärsystemkennung oder eine Standby-Systemkennung ist;
die DMI konfiguriert ist, um Daten anzuzeigen, welche die Primärsystemkennung aufweisen, und Daten zu speichern, welche die Standby-Systemkennung aufweisen.

5. Zugsteuerungs-DMI-Datenredundanzsteuersystem nach Anspruch 4, wobei die Primär-Standby-Systemkennung, die basierend auf einem Datenzustand dynamisch geändert wird, Folgendes beinhaltet:

die DMI ist konfiguriert, um erste Herzschlagdaten zu empfangen, die durch eine Hauptsteuereinheit als das Primärsystem gesendet werden, wobei sich ein erster Herzschlagdatenzustand synchron mit einem Primärsystemdatenzustand ändert;
die DMI ist konfiguriert, um zu beurteilen, ob die ersten Herzschlagdaten normal sind, und basierend auf einem Beurteilungsergebnis die folgenden Schritte auszuführen:

wenn die DMI beurteilt, dass die ersten Herzschlagdaten normal sind, Beibehalten der Primär-Standby-Systemkennung unverändert;
wenn die DMI beurteilt, dass die ersten Herzschlagdaten anormal sind, Ersetzen der Primärsystemkennung durch die Standby-Systemkennung und Ersetzen der Standby-Systemkennung durch die Primärsystemkennung.

6. Zugsteuerungs-DMI-Datenredundanzsteuersystem nach Anspruch 4, wobei die Primär-Standby-Systemkennung, die basierend auf einem Datenzustand dynamisch geändert wird, Folgendes beinhaltet:

eine Hauptsteuereinheit als das Standby-System ist konfiguriert, um zweite Herzschlagdaten zu empfangen, die durch eine Hauptsteuereinheit als das Primärsystem gesendet werden, wobei sich ein zweiter Herzschlagdatenzustand synchron mit dem Primärsystemdatenzustand ändert;
das Standby-System ist konfiguriert, um zu beurteilen, ob die zweiten Herzschlagdaten normal sind, und basierend auf einem Beurteilungsergebnis folgende Schritte auszuführen:

wenn das Standby-System beurteilt, dass die zweiten Herzschlagdaten normal sind,

Beibehalten der Primär-Standby-Systemkennung unverändert;
wenn das Standby-System beurteilt, dass die zweiten Herzschlagdaten anormal sind, Ersetzen der Primärsystemkennung durch die Standby-Systemkennung und Ersetzen der Standby-Systemkennung durch die Primärsystemkennung.

Revendications

1. Procédé de commande de redondance de données DMI de commande de train,

   ladite DMI recevant et traitant simultanément deux ensembles de données, lesdits deux ensembles de données présentant une relation principale-de secours mutuelle ; ladite DMI évaluant la relation principale-de secours sur la base d'un résultat d'analyse des données ; **caractérisé en ce que**
   le résultat d'analyse comprend un identifiant du système principal-de secours, l'identifiant du système principal-de secours étant dynamiquement modifié sur la base d'un état de données ;
   ladite DMI évaluant si l'identifiant du système principal-de secours est un identifiant du système principal ou un identifiant du système de secours ;
   ladite DMI affichant des données comportant l'identifiant du système principal, et ladite DMI stockant des données comportant l'identifiant du système de secours.

2. Procédé de commande de redondance de données DMI de commande de train selon la revendication 1, ledit identifiant du système principal-de secours qui est modifié dynamiquement sur la base d'un état de données comprenant :

   la réception, par la DMI, de premières données de rythme cardiaque envoyées par un système principal, un premier état de données de rythme cardiaque changeant de manière synchrone avec un état de données de système principal ;
   l'évaluation, par la DMI, pour savoir si les premières données de rythme cardiaque sont normales, et l'exécution, sur la base d'un résultat d'évaluation, des étapes :

      si la DMI évalue que les premières données de rythme cardiaque sont normales, de maintien de l'identifiant du système principal-de secours inchangé ;
      si la DMI évalue que les premières données de rythme cardiaque sont anormales, de remplacement de l'identifiant du système principal par l'identifiant du système de secours et de remplacement de l'identifiant du système de secours par l'identifiant du système principal.

3. Procédé de commande de redondance de données DMI de commande de train selon la revendication 1, ledit identifiant du système principal-de secours qui est modifié dynamiquement sur la base d'un état de données, comprenant :

   la réception, par le système de secours, de secondes données de rythme cardiaque envoyées par le système principal, un second état de données de rythme cardiaque changeant de manière synchrone avec l'état des données du système principal ;
   l'évaluation, par le système de secours, pour savoir si les secondes données de rythme cardiaque sont normales, et l'exécution, sur la base d'un résultat d'évaluation, des étapes :

      si le système de secours évalue que les secondes données de rythme cardiaque sont normales, de maintien de l'identifiant du système principal-de secours inchangé ;
      si le système de secours évalue que les secondes données de rythme cardiaque sont anormales, de remplacement de l'identifiant du système principal par l'identifiant du système de secours et de remplacement de l'identifiant du système de secours par l'identifiant du système principal.

4. Système de commande de redondance de données DMI de commande de train, comprenant :

   deux unités de commande principales, configurées pour envoyer respectivement des données à la DMI, les deux ensembles de données étant dans une relation principale-de secours mutuelle ; et
   la DMI, configurée pour recevoir et traiter simultanément les deux ensembles de données dans une relation principale-de secours mutuelle, et évaluer la relation principale-de secours sur la base d'un résultat d'analyse des données ;
   caractérisé en ce que
   le résultat d'analyse comprend un identifiant du système principal-de secours, l'identifiant du système principal-de secours étant dynamiquement modifié sur la base d'un état de données ;
   la DMI est configurée pour évaluer si l'identifiant du système principal-de secours est un identifiant du système principal ou un identifiant du système de secours ;
   la DMI est configurée pour afficher des données comportant l'identifiant du système principal, et

stocker des données comportant l'identifiant du système de secours.

5. Système de commande de redondance de données DMI de commande de train selon la revendication 4, ledit identifiant du système principal-de secours qui est modifié dynamiquement sur la base d'un état de données, comprenant :

la DMI est configurée pour recevoir des premières données de rythme cardiaque envoyées par une unité de commande principale en tant que système principal, un premier état de données de rythme cardiaque changeant de manière synchrone avec un état de données de système principal ;
la DMI est configurée pour évaluer si les premières données de rythme cardiaque sont normales, et exécuter, sur la base d'un résultat d'évaluation, les étapes :

si la DMI évalue que les premières données de rythme cardiaque sont normales, de maintien de l'identifiant du système principal-de secours inchangé ;
si la DMI évalue que les premières données de rythme cardiaque sont anormales, de remplacement de l'identifiant du système principal par l'identifiant du système de secours et de remplacement de l'identifiant du système de secours par l'identifiant du système principal.

6. Système de commande de redondance de données DMI de commande de train selon la revendication 4, ledit identifiant du système principal-de secours qui est modifié dynamiquement sur la base d'un état de données, comprenant :

une unité de commande principale en tant que système de secours est configurée pour recevoir des secondes données de rythme cardiaque envoyées par une unité de commande principale en tant que système principal, un second état de données de rythme cardiaque changeant de manière synchrone avec l'état des données du système principal ;
le système de secours est configuré pour évaluer si les secondes données de rythme cardiaque sont normales, et exécuter, sur la base d'un résultat d'évaluation, les étapes :

si le système de secours évalue que les secondes données de rythme cardiaque sont normales, de maintien de l'identifiant du système principal-de secours inchangé ;
si le système de secours évalue que les secondes données de rythme cardiaque sont anormales, de remplacement de l'identifiant du système principal par l'identifiant du système de secours et de remplacement de l'identifiant du système de secours par l'identifiant du système principal.

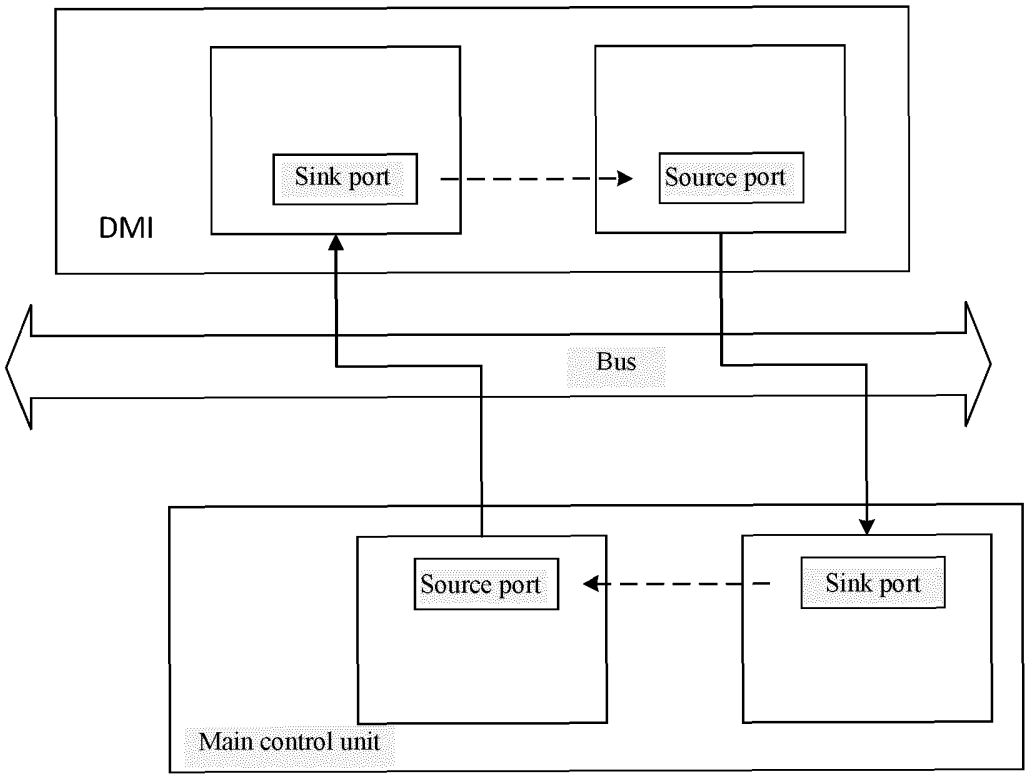

DMI
Sink port
Source port
Bus
Source port
Sink port
Main control unit

FIG. 1

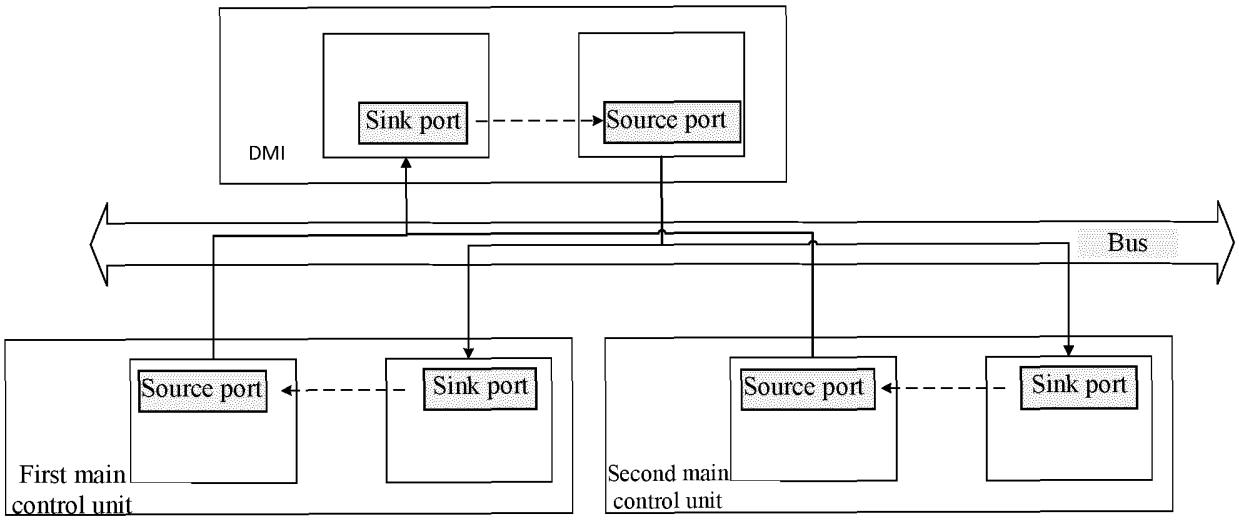

DMI
Sink port
Source port
Bus
Source port
Sink port
First main control unit
Source port
Sink port
Second main control unit

FIG. 2

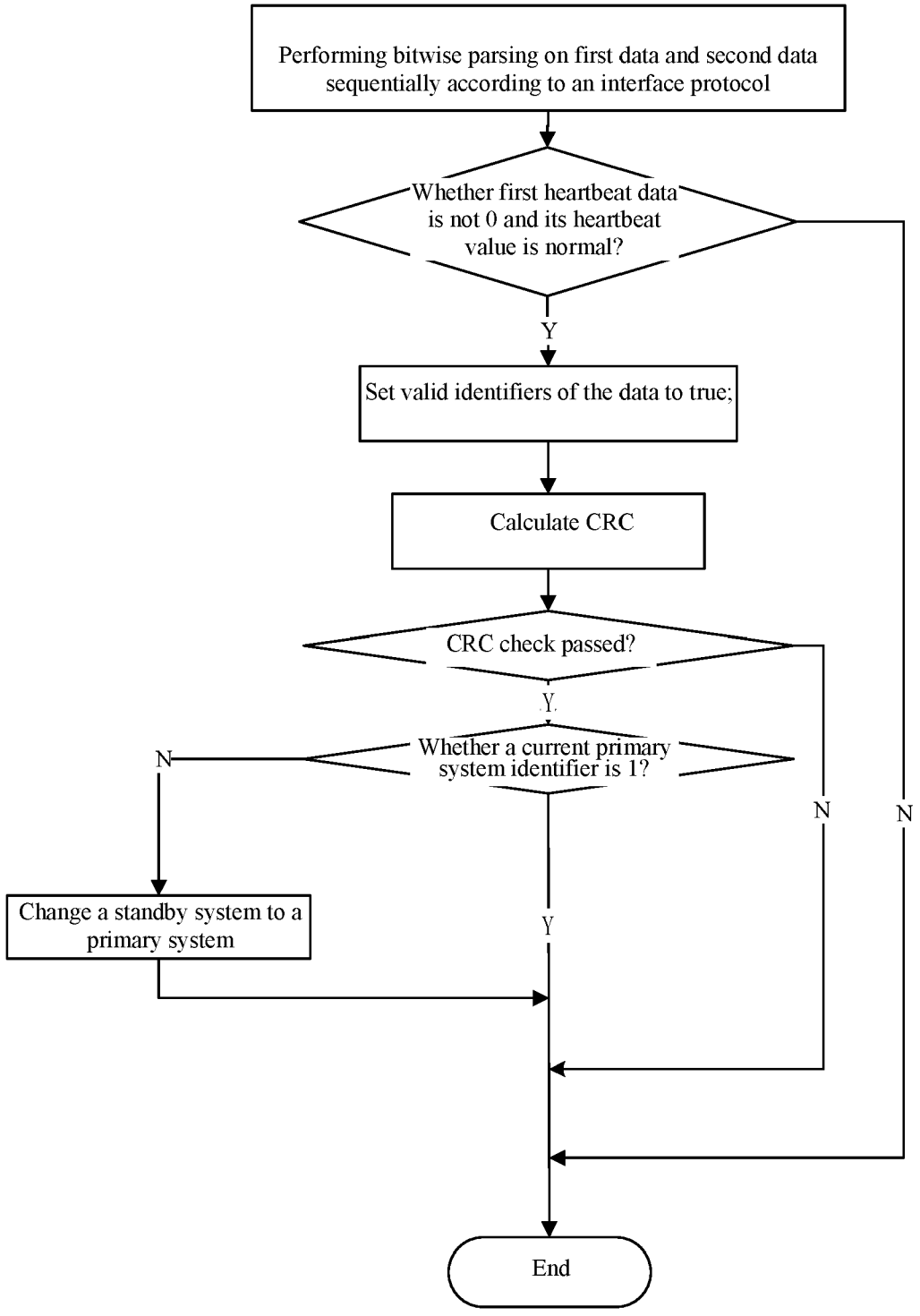

Performing bitwise parsing on first data and second data sequentially according to an interface protocol
Whether first heartbeat data is not 0 and its heartbeat value is normal?
Y
Set valid identifiers of the data to true;
Calculate CRC
CRC check passed?
Y
Whether a current primary system identifier is 1?
N
Change a standby system to a primary system
Y
N
N
End

FIG.3

Primary-standby system identifier	Data	CRC code

FIG. 4

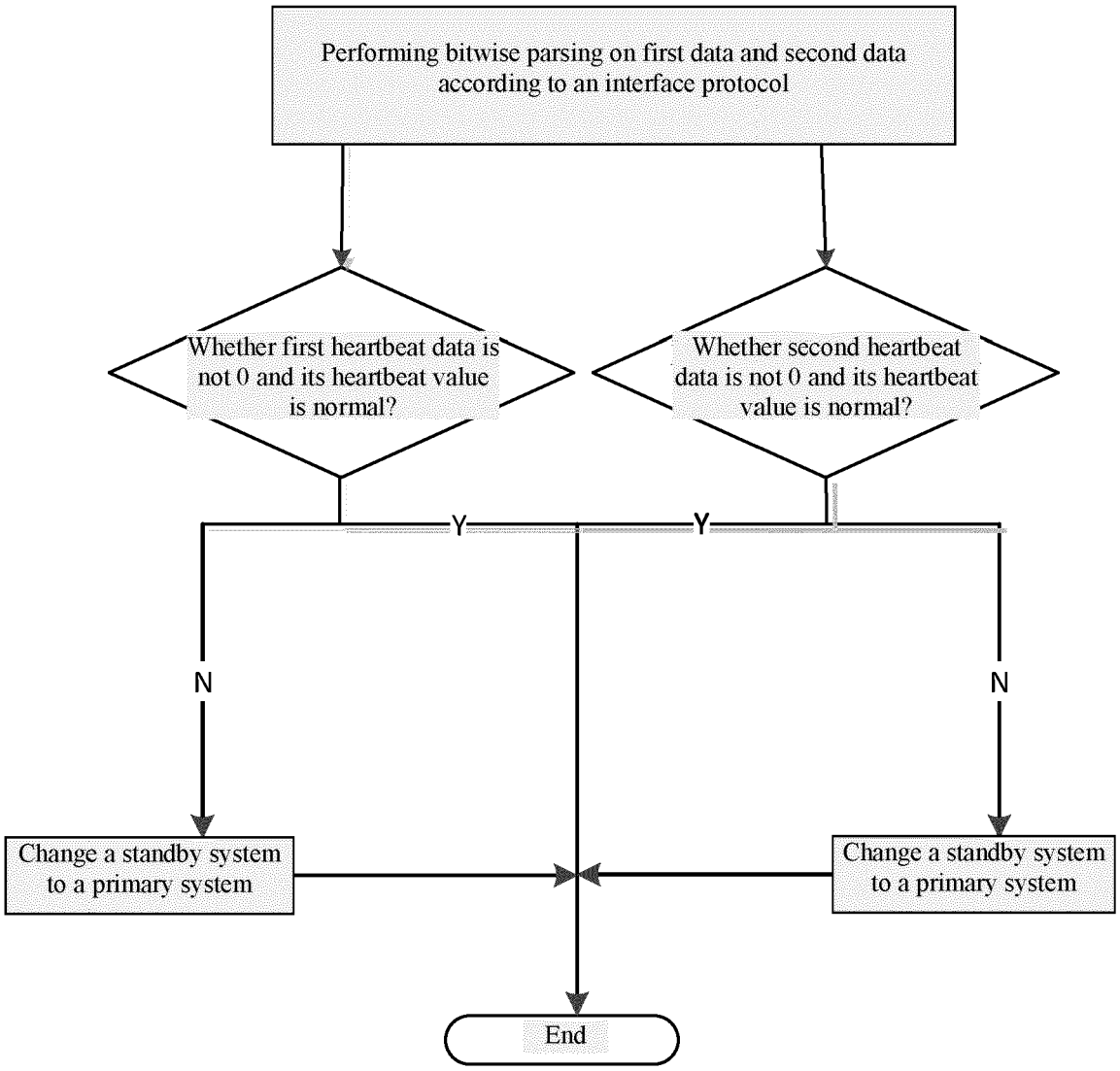


FIG. 5

REFERENCES CITED IN THE DESCRIPTION

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