



(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
02.06.2021 Bulletin 2021/22

(51) Int Cl.:
B61L 15/00 (2006.01)

(21) Application number: **20785892.9**

(86) International application number:
PCT/CN2020/108331

(22) Date of filing: **11.08.2020**

(87) International publication number:
WO 2021/073221 (22.04.2021 Gazette 2021/16)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME KH MA MD TN

(72) Inventors:
• **ZHU, Zhicheng**
Beijing 100070 (CN)
• **WANG, Jianmin**
Beijing 100070 (CN)
• **ZHANG, Youbing**
Beijing 100070 (CN)
• **YU, Xiaona**
Beijing 100070 (CN)

(30) Priority: **17.10.2019 CN 201910988880**

(71) Applicant: **CRSC Research & Design Institute Group Co., Ltd.**
Beijing 100070 (CN)

(74) Representative: **Huang, Liwei**
Cäcilienstraße 12
40597 Düsseldorf (DE)

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

(57) The present invention proposes a train control DMI data redundancy control method and system; the DMI simultaneously receives and processes two sets of data in a mutual primary-standby relationship, the DMI judges the primary-standby relationship based on a parsing result of the data, and the DMI displays primary system data; the system comprises 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, judge the primary-standby relationship based on a parsing result of the data, and display primary system data; the DMI simultaneously receives the data sent by the two main control units, and respectively uses the two main control units as a primary system and a standby system according to two primary-standby system identifiers; when the primary system is abnormal, the two primary-standby system identifiers change, and the driver machine interface switches the primary system and the standby system after identifying change of the two primary-standby system identifiers, without affecting content displayed by the DMI, and without configuring a switching module, which has a simple structure and high switching efficiency.

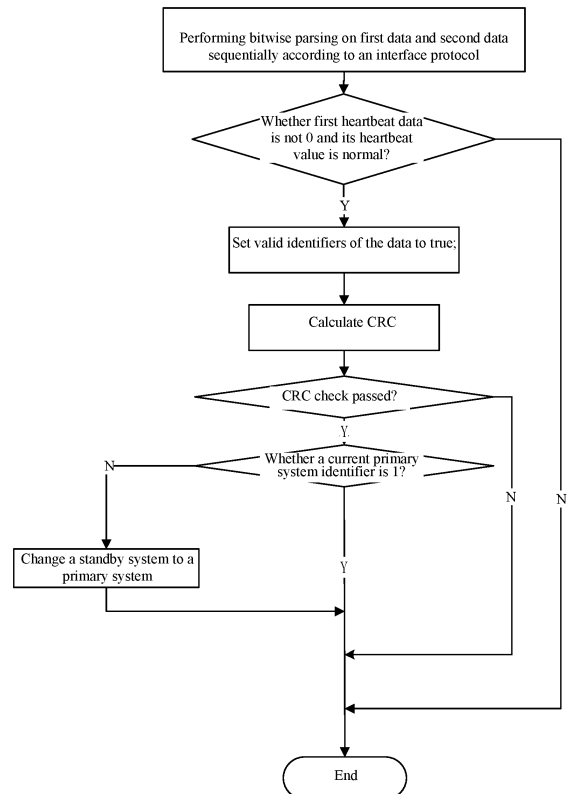


FIG.3

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.

SUMMARY

[0006] With respect to the above-described problems, the present disclosure proposes a train control DMI data redundancy control method, wherein:

The DMI simultaneously receives and processes two sets of data in a mutual primary-standby relationship; the DMI judges the primary-standby relationship based on a parsing result of the data; and the DMI displays primary system data.

[0007] Preferably, the DMI stores standby system data.

[0008] Preferably, 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.

[0009] Preferably, 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, a first heartbeat data state synchronously changing 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.

[0010] Preferably, 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, a second heartbeat data state synchronously changing 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.

[0011] Preferably, the DMI receives third heartbeat data sent by the primary system, a third heartbeat data state synchronously changing with the primary system data state;

The DMI judges whether the third heartbeat data is normal, and executes, based on a judgment result, steps of:

If the DMI judges that the third heartbeat data is normal, maintaining the primary-standby system unchanged;

If the DMI 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.

[0012] The present disclosure further proposes 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 two sets of data in a mutual primary-standby relationship, judge the primary-standby relationship based on a parsing result of the data, and display primary system data.

[0013] Preferably, the DMI is configured to store standby system data.

[0014] Preferably, 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.

[0015] Preferably, 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, a first heartbeat data state synchronously changing 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.

[0016] Preferably, the primary-standby system identifier being dynamically changed based on a data state, includes:

A main control unit as the standby system receives second heartbeat data sent by a main control unit as the primary system, a second heartbeat data state synchronously changing 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.

[0017] Preferably, the DMI is configured to receive third heartbeat data sent by the main control unit as the primary system, a third heartbeat data state synchronously changing with the primary system data state;

The DMI is configured to judge whether the third heartbeat data is normal, and execute, based on a judgment result, steps of:

If the DMI judges that the third heartbeat data is normal, maintaining the primary-standby systems unchanged;

If the DMI 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.

[0018] In the train control DMI data redundancy control method and system according to the present disclosure, 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.

[0019] 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

[0020] 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 disclosure; based on the drawings, those ordinarily skilled in the art can acquire other drawings, without any inventive work.

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 disclosure;

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

[0021] In order to make objectives, technical details and advantages of the embodiments of the present disclosure 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 disclosure. It is obvious that the described embodiments are just a part but not all of the embodiments of the present disclosure. Based on the described embodiments herein, those ordinarily skilled in the art can obtain other embodiment(s), without any inventive work, which should be within the scope of the present disclosure.

[0022] 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.

[0023] 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;

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;

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.

[0024] 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.

[0025] 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.

[0026] 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.

[0027] 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 control unit, so that the first main control unit can monitor a state of the second main control unit.

[0028] 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.

[0029] 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;

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.

[0030] 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.

[0031] 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.

[0032] 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.

[0033] 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.

[0034] 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.

[0035] 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.

[0036] 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.

[0037] 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.

[0038] 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.

[0039] 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.

[0040] 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.

[0041] 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.

[0042] 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.

[0043] In another design mode, 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; The driver machine interface judges whether the third heartbeat data is normal, and executes, based on a judgment result, steps of:

If the driver machine interface judges that the third heartbeat data is normal, maintaining the primary-standby systems unchanged;
If the driver machine interface judges that the third heartbeat data is abnormal, changing the primary system data to the standby system data, and chang-

ing the standby system data to the primary system data.

[0044] 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.

[0045] Although the present disclosure is explained in detail with reference to the foregoing embodiments, those ordinarily skilled in the art will readily appreciate that many modifications are possible in the foregoing respective embodiments, or equivalent substitutions are made for part of technical features; however, these modifications or substitutions are not intended to make the essences of the corresponding technical solutions depart from the spirit and the scope of the technical solutions of the respective embodiments of the present disclosure.

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; and the DMI displays primary system data.
2. The train control DMI data redundancy control method according to claim 1, wherein, the DMI stores standby system data.
3. The train control DMI data redundancy control method according to claim 1 or 2, wherein, 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.
4. The train control DMI data redundancy control meth-

od according to claim 3, wherein,
the primary-standby system identifier being dynam-
ically 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 prima-
ry system data state;
judging, by the DMI, whether the first heartbeat
data is normal, and executing, based on a judg-
ment 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.

5. The train control DMI data redundancy control meth-
od according to claim 3, wherein,
the primary-standby system identifier being dynam-
ically changed based on a data state, includes:

receiving, by the standby system, second heart-
beat data sent by the primary system, wherein
a second heartbeat data state changes synchro-
nously 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 un-
changed;
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.

6. The train control DMI data redundancy control meth-
od according to claim 1 or 2, wherein,
the DMI receives third heartbeat data sent by the
primary system, wherein a third heartbeat data state
changes synchronously with the primary system da-
ta state;
the DMI judges whether the third heartbeat data is
normal, and executes, based on a judgment result,
steps of:

if the DMI judges that the third heartbeat data is
normal, maintaining the primary-standby sys-
tems unchanged;

if the DMI 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.

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

two main control units, configured to respective-
ly 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, judge the primary-
standby relationship based on a parsing result
of the data, and display primary system data.

8. The train control DMI data redundancy control sys-
tem according to claim 7, wherein, the DMI is con-
figured to store standby system data.

9. The train control DMI data redundancy control sys-
tem according to claim 7 or 8, wherein, the parsing
result includes a primary-standby system identifier,
the primary-standby system identifier being dynam-
ically changed based on a data state;
the DMI is configured to judge whether the primary-
standby system identifier is a primary system iden-
tifier or a standby system identifier;
the DMI is configured to display data having the pri-
mary system identifier, and store data having the
standby system identifier.

10. The train control DMI data redundancy control sys-
tem according to claim 9, wherein,
the primary-standby system identifier being dynam-
ically 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.

11. The train control DMI data redundancy control sys-

tem according to claim 9, wherein,
the primary-standby system identifier being dynam-
ically changed based on a data state, includes:

a main control unit as the standby system is con- 5
figured 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 10
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 15
heartbeat data is normal, maintaining the
primary-standby system identifier un-
changed;
if the standby system judges that the second 20
heartbeat data is abnormal, replacing the
primary system identifier with the standby
system identifier and replacing the standby
system identifier with the primary system 25
identifier.

12. The train control DMI data redundancy control sys-
tem according to claim 7 or 8, wherein,
the DMI is configured to receive third heartbeat data
sent by a main control unit as the primary system, 30
wherein a third heartbeat data state changes syn-
chronously with the primary system data state;
the DMI is configured to judge whether the third
heartbeat data is normal, and execute, based on a
judgment result, steps of: 35

if the DMI judges that the third heartbeat data is
normal, maintaining the primary-standby sys-
tems unchanged;
if the DMI judges that the third heartbeat data is 40
abnormal, changing the primary system data to
the standby system data, and changing the
standby system data to the primary system data.

45

50

55

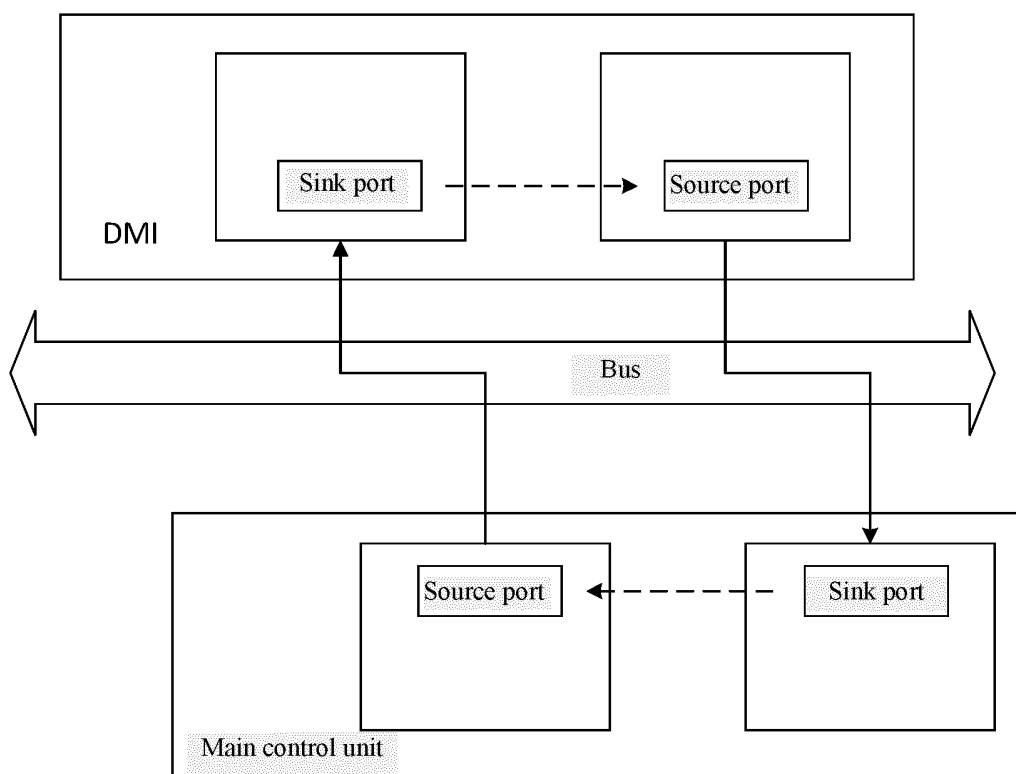


FIG. 1

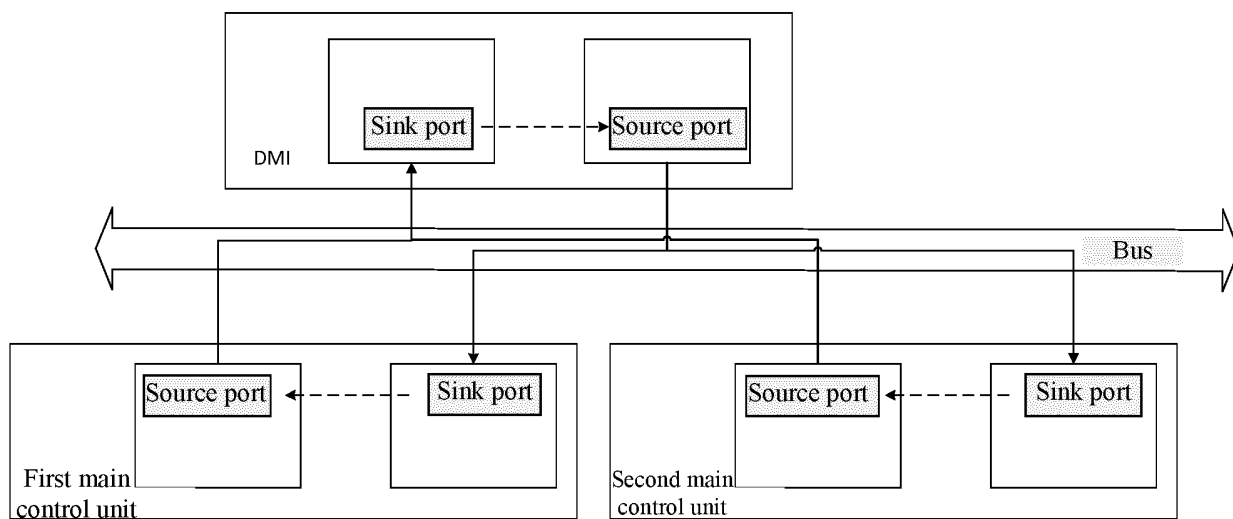


FIG. 2

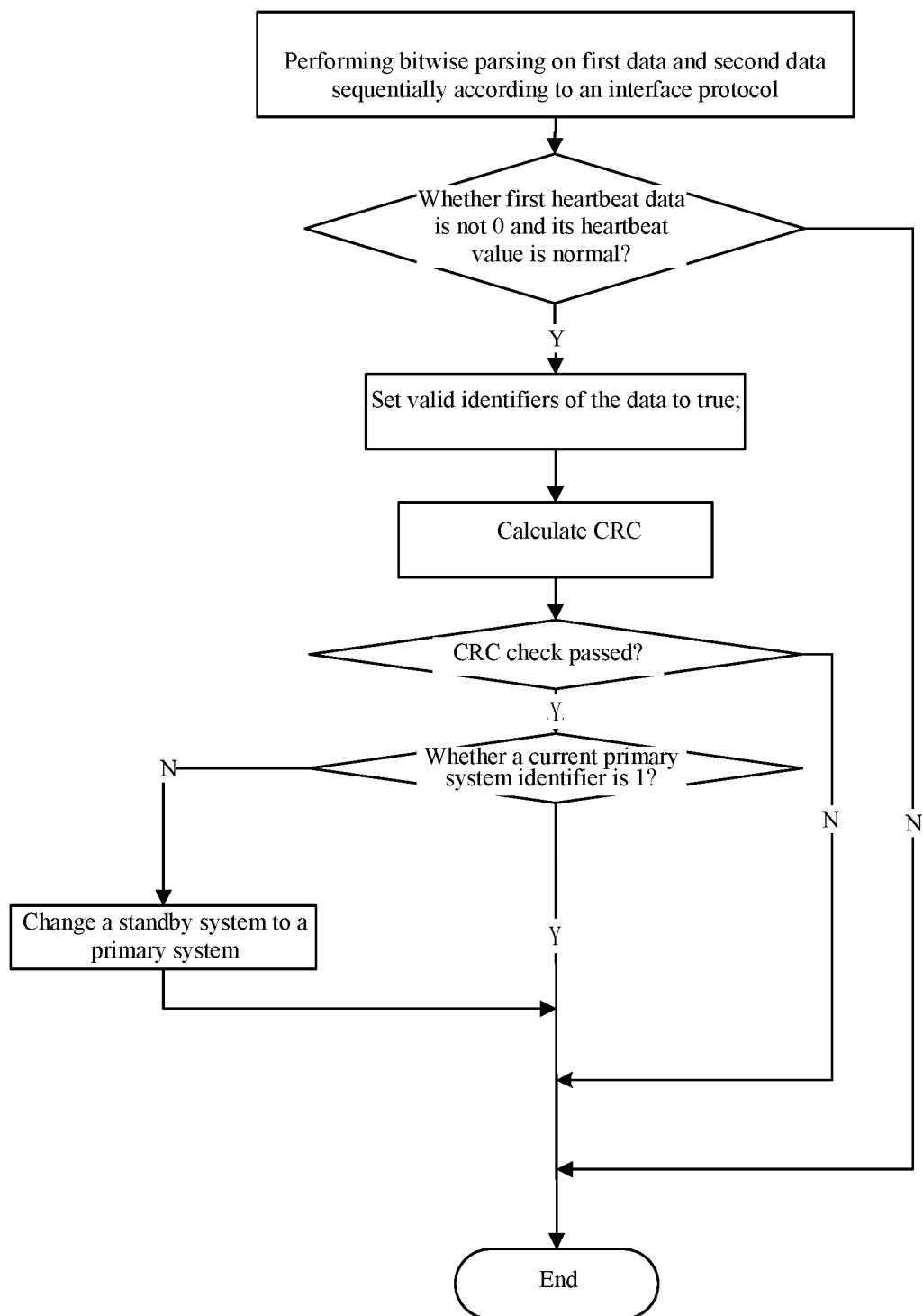


FIG.3

Primary-standby system identifier	Data	CRC code
--------------------------------------	------	----------

FIG. 4

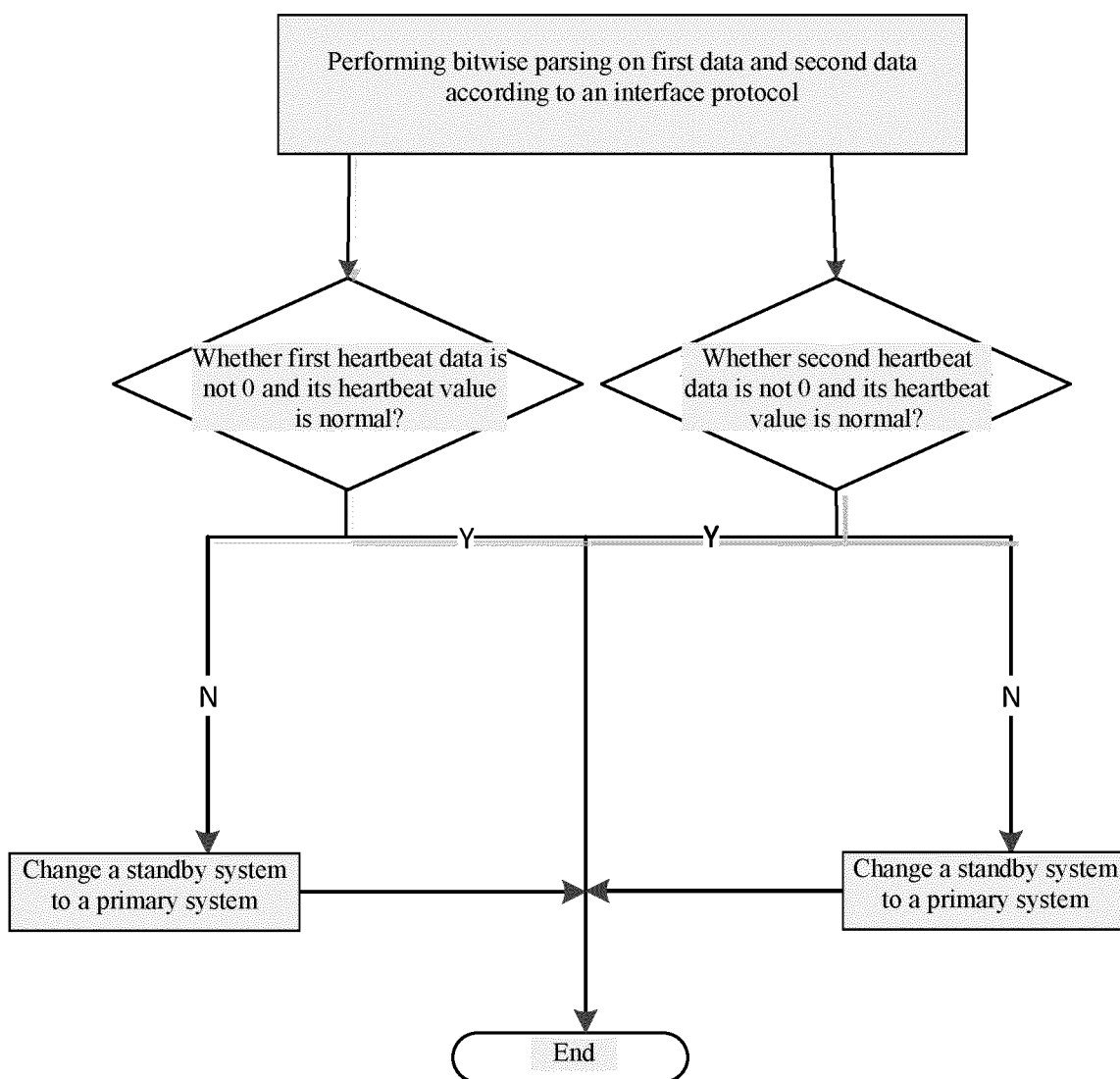


FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2020/108331

A. CLASSIFICATION OF SUBJECT MATTER B61L 15/00(2006.01)i According to International Patent Classification (IPC) or to both national classification and IPC	B. FIELDS SEARCHED																		
Minimum documentation searched (classification system followed by classification symbols) B61L	Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched																		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) VEN; CNABS; CNTXT; CNKI: 列车, 控制, 列控, 控, DMI, 数据, 冗余, 主, 备, 系, 关系, 两系, 标识, 切换, 显示, 人机交换, 心跳, 双机热备, data, prim+, display+, principal, train, driver, backup, control, relation+, machine, interface, master, main, standby																			
C. DOCUMENTS CONSIDERED TO BE RELEVANT																			
<table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>PX</td> <td>CN 110789569 A (CRSC RESEARCH & DESIGN INSTITUTE GROUP CO., LTD.) 14 February 2020 (2020-02-14) claims 1-12</td> <td>1-12</td> </tr> <tr> <td>X</td> <td>CN 109720379 A (HENAN THINKER AUTOMATIC EQUIPMENT CO., LTD.) 07 May 2019 (2019-05-07) description, paragraphs 4-21, figure 1</td> <td>1-3, 7-9</td> </tr> <tr> <td>Y</td> <td>CN 109720379 A (HENAN THINKER AUTOMATIC EQUIPMENT CO., LTD.) 07 May 2019 (2019-05-07) description, paragraphs 4-21, figure 1</td> <td>4-6, 10-12</td> </tr> <tr> <td>Y</td> <td>CN 105450446 A (MIANYANG WEIBO ELECTRONIC CO., LTD.) 30 March 2016 (2016-03-30) description, paragraphs 7-68, figures 1-6</td> <td>4-6, 10-12</td> </tr> <tr> <td>A</td> <td>CN 109367578 A (CASCO SIGNAL LTD.) 22 February 2019 (2019-02-22) entire document</td> <td>1-12</td> </tr> </tbody> </table>	Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	PX	CN 110789569 A (CRSC RESEARCH & DESIGN INSTITUTE GROUP CO., LTD.) 14 February 2020 (2020-02-14) claims 1-12	1-12	X	CN 109720379 A (HENAN THINKER AUTOMATIC EQUIPMENT CO., LTD.) 07 May 2019 (2019-05-07) description, paragraphs 4-21, figure 1	1-3, 7-9	Y	CN 109720379 A (HENAN THINKER AUTOMATIC EQUIPMENT CO., LTD.) 07 May 2019 (2019-05-07) description, paragraphs 4-21, figure 1	4-6, 10-12	Y	CN 105450446 A (MIANYANG WEIBO ELECTRONIC CO., LTD.) 30 March 2016 (2016-03-30) description, paragraphs 7-68, figures 1-6	4-6, 10-12	A	CN 109367578 A (CASCO SIGNAL LTD.) 22 February 2019 (2019-02-22) entire document	1-12	
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.																	
PX	CN 110789569 A (CRSC RESEARCH & DESIGN INSTITUTE GROUP CO., LTD.) 14 February 2020 (2020-02-14) claims 1-12	1-12																	
X	CN 109720379 A (HENAN THINKER AUTOMATIC EQUIPMENT CO., LTD.) 07 May 2019 (2019-05-07) description, paragraphs 4-21, figure 1	1-3, 7-9																	
Y	CN 109720379 A (HENAN THINKER AUTOMATIC EQUIPMENT CO., LTD.) 07 May 2019 (2019-05-07) description, paragraphs 4-21, figure 1	4-6, 10-12																	
Y	CN 105450446 A (MIANYANG WEIBO ELECTRONIC CO., LTD.) 30 March 2016 (2016-03-30) description, paragraphs 7-68, figures 1-6	4-6, 10-12																	
A	CN 109367578 A (CASCO SIGNAL LTD.) 22 February 2019 (2019-02-22) entire document	1-12																	
☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.																			
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family																		
Date of the actual completion of the international search 03 November 2020	Date of mailing of the international search report 11 November 2020																		
Name and mailing address of the ISA/CN China National Intellectual Property Administration (ISA/CN) No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088 China	Authorized officer																		
Facsimile No. (86-10)62019451	Telephone No.																		

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2020/108331

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 109649446 A (CHINA ACADEMY OF RAILWAY SCIENCES CORPORATION LIMITED, SIGNAL & COMMUNICATION RESEARCH INSTITUTE et al.) 19 April 2019 (2019-04-19) entire document	1-12
A	CN 109739694 A (CHINA SOUTH INDUSTRIES GROUP CORPORATION INSTITUTE OF AUTOMATION) 10 May 2019 (2019-05-10) entire document	1-12
A	CN 103019218 A (BEIJING NATIONAL RAILWAY LUYANG TECHNOLOGY CO., LTD.) 03 April 2013 (2013-04-03) entire document	1-12
A	CN 108092752 A (CRSC RESEARCH & DESIGN INSTITUTE GROUP CO., LTD.) 29 May 2018 (2018-05-29) entire document	1-12
A	CN 109823375 A (CRSC RESEARCH & DESIGN INSTITUTE GROUP CO., LTD.) 31 May 2019 (2019-05-31) entire document	1-12
A	CN 109946956 A (CRSC RESEARCH & DESIGN INSTITUTE GROUP CO., LTD.) 28 June 2019 (2019-06-28) entire document	1-12
A	CN 105539522 A (ZHUZHOU CRRC TIMES ELECTRIC CO., LTD.) 04 May 2016 (2016-05-04) entire document	1-12
A	CN 105790825 A (ZTE CORPORATION) 20 July 2016 (2016-07-20) entire document	1-12
A	DE 102009025550 A1 (SIEMENS AG) 16 December 2010 (2010-12-16) entire document	1-12
A	KR 20130013794 A (HYUNDAI ROTEM COMPANY) 06 February 2013 (2013-02-06) entire document	1-12

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2020/108331

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
CN 110789569 A	14 February 2020	None	
CN 109720379 A	07 May 2019	None	
CN 105450446 A	30 March 2016	None	
CN 109367578 A	22 February 2019	None	
CN 109649446 A	19 April 2019	None	
CN 109739694 A	10 May 2019	None	
CN 103019218 A	03 April 2013	CN 103019218 B	20 August 2014
CN 108092752 A	29 May 2018	WO 2019095647 A1	23 May 2019
		EA 201992084 A1	30 July 2020
CN 109823375 A	31 May 2019	WO 2020143243 A1	16 July 2020
CN 109946956 A	28 June 2019	None	
CN 105539522 A	04 May 2016	None	
CN 105790825 A	20 July 2016	US 2018269963 A1	20 September 2018
		EP 3247055 A1	22 November 2017
		EP 3247055 A4	14 November 2018
		CN 105790825 B	14 August 2020
		WO 2016101825 A1	30 June 2016
DE 102009025550 A1	16 December 2010	EP 2443016 B1	03 April 2013
		ES 2410806 T3	03 July 2013
		WO 2010145941 A1	23 December 2010
		EP 2443016 A1	25 April 2012
KR 20130013794 A	06 February 2013	KR 101275027 B1	17 June 2013

Form PCT/ISA/210 (patent family annex) (January 2015)