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(54) METHOD FOR PROCESSING TRAIN INTERFACE DATA OF HOT-STANDBY VEHICLE-MOUNTED DEVICE

VERFAHREN ZUR VERARBEITUNG VON ZUGSCHNITTSTELLENDATEN EINES HOT-STANDBY-BORDGERÄTS

PROCÉDÉ DE TRAITEMENT DE DONNÉES D'INTERFACE DE TRAIN DE DISPOSITIF EMBARQUÉ EN RÉSERVE INSTANTANÉE

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Description

TECHNICAL FIELD

[0001] The present invention relates to the field of train control technology, and more particularly, to a method for processing train interface data of hot standby on-board equipment.

BACKGROUND

[0002] The train operation control system is a system to ensure safe and fast operation of trains. The main function of the train operation control system is to complete interval control and speed control of the trains. The complete train operation control system consists of on-board equipment and ground equipment.

[0003] Chinese Patent 201910236866.5 (CN 109 946 956 A) discloses a method of synchronizing main and standby systems.

[0004] Existing on-board equipment generally adopts a second main control unit for cold backup or warm backup of a first main control unit, which has the following problems:

when the first main control unit which is operating fails, the trains are required to stop so as to switch from the first main control unit to the second main control unit.

SUMMARY

[0005] In order to overcome the shortcomings of the prior art, the present invention provides a method for processing train interface data of hot standby on-board equipment, which solves the problem that existing on-board equipment generally adopts a second main control unit for cold backup or warm backup of a first main control unit, when the first main control unit which is operating fails, the trains are required to stop so as to switch from the first main control unit to the second main control unit.

[0006] The present invention provides a method for processing train interface data for a hot standby on-board equipment, as described in claim 1, as well as advantageous embodiments as described in claims 2 to 6.

[0007] The present invention is specifically implemented through the following technical solutions:

A method for processing train interface data of hot standby on-board equipment according to the present invention, which specifically comprises:

a second main control unit is used for hot backup of a first main control unit, power is supplied to the first main control unit and the second main control unit concurrently;

the first main control unit and the second main control unit receive input signals transmitted by a train interface, and control the input signals to maintain consistent;

when the on-board equipment loses power, or the first main control unit and the second main control unit both fail, the on-board equipment transmits a safety command to the train interface;

when at least one of the first main control unit and the second main control unit is in a normal operating state, the on-board equipment determines whether to transmit a safety command to the train interface according to an operating situation.

[0008] Further, controlling the input signals to maintain consistent specifically comprises the following steps:

S 1: the second main control unit receives a currently collected first input signal transmitted by the first main control unit;

S2: the second main control unit compares the first input signal with a currently collected second input signal; if signal content of the first input signal and signal content of the second input signal are consistent, the first main control unit uses the currently collected first input signal as input and the second main control unit uses the currently collected second input signal as input; if signal content of the first input signal and signal content of the second input signal are inconsistent, the first main control unit discards the first input signal and the second main control unit discards the second input signal, the first main control unit and the second main control unit maintain previous consistent signals as input.

[0009] Further, when signal content of the first input signal and signal content of the second input signal are inconsistent, it is determined that the second main control unit fails if a time period for which signal content of the first input signal and signal content of the second input signal are inconsistent exceeds a prescribed time period.

[0010] Further, controlling the input signals to maintain consistent specifically is:

the first main control unit receives a current input signal, and transmits the input signal to the second main control unit;

the second main control unit receives the input signal as its own input signal.

[0011] Further, when at least one of the first main control unit and the second main control unit is in a normal operating state, the on-board equipment determines whether to transmit a safety command to the train interface according to an operating situation:

when the first main control unit fails or has no power, the second main control unit determines according to needs whether to transmit a safety command to the train interface;

or, when the second main control unit fails or has no power, the first main control unit determines according to needs whether to transmit a safety command

to the train interface;
or, when the first main control unit and the second main control unit are both operating normally, the second main control unit continues to transmit a safety command to a circuit module within the on-board equipment; the first main control unit determines according to needs whether to transmit a safety command to the circuit module; a safety command is transmitted to the train interface if the circuit module receives the safety command of the second main control unit and the safety command of the first main control unit; no safety command is transmitted to the train interface if the circuit module only receives the safety command of the second main control unit.

[0012] Further, when at least one of the first main control unit and the second main control unit is in a normal operating state, the on-board equipment determines whether to transmit a safety command to the train interface according to an operating situation:

when the first main control unit fails or has no power, the second main control unit determines according to needs whether to transmit a safety command to the train interface;
or, when the second main control unit fails or has no power, the first main control unit determines according to needs whether to transmit a safety command to the train interface;
or, when the first main control unit and the second main control unit are both operating normally, the first main control unit or the second main control unit determines whether to transmit a safety command to the train interface according to states of a local end and a peer end.

[0013] Further, when the first main control unit and the second main control unit are both operating normally, the first main control unit or the second main control unit determines whether to transmit a safety command to the train interface or to cancel transmitting a safety command to the train interface according to states of a local end and a peer end, which specifically comprises:

T1: initially, both the local end and the peer end are in an idle state;
T2: when the local end transmits a safety command to the train interface, it is determined whether a transmitting state of the safety command changes; in the case where the transmitting state of the safety command changes, a first timer is started, a state of monitoring a peer end is entered, step T3 is executed; in the case where a transmitting state of the safety command does not change, it is determined whether safety command information of the peer end is received, if safety command information of the peer end is received, an acknowledgement packet of having received the safety command information is transmitted to the peer end, and a second timer is started, a state of monitoring the local end is entered, step T4 is executed; if no safety command information of the peer end is received, it continues to determine whether the transmitting state of the safety command of the local end changes;
T3: it is determined whether the changed transmitting state of the safety command is to transmit a safety command to the train interface; if the changed transmitting state of the safety command is to transmit a safety command to the train interface, the local end transmits a safety command to the train interface and periodically transmits, to the peer end, information for transmitting safety command to the train interface, it continues to execute step T3-1; if the changed safety command transmitting state is to not transmit a safety command to the train interface, the local end will not transmit a safety command to the train interface temporarily, and periodically transmits, to the peer end, information for not transmitting a safety command to the train interface, it continues to execute step T3-2;
T3-1: it is determined whether safety command information of the peer end is received; if safety command information of the peer end is received, an acknowledgement packet of having received the safety command information is transmitted to the peer end, and it is determined whether the safety command information of the peer end and the changed transmitting state of the safety command of the local end are consistent; if the safety command information of the peer end and the changed transmitting state of the safety command of the local end are consistent, the first timer is closed, the local end enters an idle state; if the safety command information of the peer end and the changed transmitting state of the safety command of the local end are inconsistent, the local end enters a fault state; if no safety command information of the peer end is received, it is determined whether timing of the first timer expires; if timing of the first timer expires, the first timer is closed, the local end enters the idle state; if timing of the first timer does not expire, it is determined whether an acknowledgement packet for safety command information of the peer end is received; if an acknowledgement packet for safety command information of the peer end is received, it stops transmitting, to the peer end, information for transmitting safety command information to the train interface, a current state is maintained; if no acknowledgement packet for safety command information of the peer end is received, it is determined whether the information for transmitting safety command information to the train interface has been transmitted to the peer end for more than a specified number of times; if the information for transmitting safety command information to the train interface has been transmitted to the peer end for more than the spec-

ified number of times, it stops transmitting, to the peer end, information for transmitting safety command information to the train interface, and the local end enters a fault state; if the information for transmitting safety command information to the train interface has not been transmitted to the peer end for more than the specified number of times, it continues to transmit, to the peer end, information for transmitting safety command information to the train interface;

T3-2: it is determined whether safety command information of the peer end is received; if safety command information of the peer end is received, an acknowledgement packet of having received the safety command information is transmitted to the peer end, and it is determined whether the safety command information of the peer end and the changed transmitting state of the safety command of the local end are consistent; if the safety command information of the peer end and the changed transmitting state of the safety command of the local end are consistent, the first timer is closed, the local end enters an idle state; if the safety command information of the peer end and the changed transmitting state of the safety command of the local end are inconsistent, the local end enters a fault state; if no safety command information of the peer end is received, it is determined whether timing of the first timer expires; if timing of the first timer expires, the first timer is closed, the local end enters the idle state; if timing of the first timer does not expire, it is determined whether an acknowledgement packet for safety command information of the peer end is received; if an acknowledgement packet for safety command information of the peer end is received, it stops transmitting, to the peer end, information for not transmitting safety command information to the train interface, a current state is maintained; if no acknowledgement packet for safety command information of the peer end is received, it is determined whether the information for not transmitting safety command information to the train interface has been transmitted to the peer end for more than a specified number of times; if the information for not transmitting safety command information to the train interface has been transmitted to the peer end for more than the specified number of times, it stops transmitting, to the peer end, information for transmitting safety command information to the train interface, and the local end enters a fault state; if the information for not transmitting safety command information to the train interface has not been transmitted to the peer end for more than the specified number of times, it continues to transmit, to the peer end, information for not transmitting safety command information to the train interface;

T4: when the local end transmits a safety command to the train interface, it is determined whether a transmitting state of the safety command changes; in the case where the transmitting state of the safety command changes, it is determined whether the changed transmitting state of the safety command of the local end is consistent with the safety command information of the peer end as received; if the changed transmitting state of the safety command of the local end is consistent with the safety command information of the peer end as received, the local end maintains the changed transmitting state of the safety command, and transmits the changed safety command information to the peer end, the second timer is turned off, it enters a state of waiting for acknowledgement from the peer end, it continues to execute step T5; if the changed transmitting state of the safety command is inconsistent with the safety command information of the peer as received, the second timer is closed, the local end enters a fault state; if the answer is negative, it is determined whether the second timer expires; if the second timer expires, the second timer is closed, it enters a fault state; if the second timer does not expire, it continues to determine whether a transmitting state of the safety command changes when the local end transmits a safety command to the train interface.

T5: the changed safety command information is transmitted to the peer end periodically, it is determined whether acknowledgement information about the safety command of the peer end is received; if acknowledgement information about the safety command of the peer end is received, the local end enters an idle state; if no acknowledgement information about the safety command of the peer end is received, it is determined whether the number of times of transmitting the changed safety command information to the peer end exceeds the specified number of times; if the number of times of transmitting the changed safety command information to the peer end exceeds the specified number of times, the local end enter an idle state; if the number of times of transmitting the changed safety command information to the peer end does not exceed the specified number of times, it continues to transmit the changed safety command information to the peer end.

[0014] Further, the safety command includes a speed control command and a traction removing command.

[0015] Further, the safety command includes a train interface control command;

when at least one of the first main control unit and the second main control unit is in a normal operating state, the on-board equipment determines whether to transmit the train interface control command to the train interface according to an operating situation, which specifically comprises:

when the first main control unit fails or has no power, the first main control unit does not transmit the train

interface control command to the train interface, the second main control unit determines according to needs whether to transmit the train interface control command to the train interface;
or, when the second main control unit fails or has no power, the second main control unit does not transmit the train interface control command to the train interface, the first main control unit determines according to needs whether to transmit the train interface control command to the train interface;
or, the first main control unit and the second main control unit are both in a normal operating state, the second main control unit cancels transmitting the train interface control command to a circuit module within the on-board equipment; the first main control unit determines according to needs whether to transmit the train interface control command to the circuit module; the train interface control command is not transmitted to the train interface if the circuit module does not receive the train interface control command; the train interface control command is transmitted to the train interface if the circuit module receives information for the train interface control command of the first main control unit.

[0016] Further, the method further comprises a brake test of the on-board equipment, and the brake test comprises the following steps:

D1: after the first main control unit receives a brake test request, a brake test is performed; if the brake test fails, a driver is reminded of that the brake test fails, the brake test is re-executed until the brake test is successful; if the brake test is successful, the second main control unit is instructed to perform a brake test;
D2: after the second main control unit receives the command and transmits a command receipt acknowledgement to the first main control unit, the second main control unit starts to perform a brake test; if the brake test is successful, a brake test result is transmitted to the first main control unit, the first main control unit feeds back brake test results of the local end and the second main control unit to the driver;
if the brake test fails, it is determined whether the number of times of braking exceeds a specified number of times, step D3 is executed in the case where it exceeds, step D4 is executed in the case where it does not exceed;
D3: the brake test is repeated until the brake test is successful, thereafter the brake test result is transmitted to the first main control unit, the first main control unit feeds back the brake test results of the local end and the second main control unit to the driver;
D4: the first main control unit is informed of test end, the second main control unit enters a fault state; after the first main control unit receives a test end message of the second main control unit, it will feed back the brake test result of the first main control unit to the driver.

[0017] Compared with the closest prior art, the technical solutions of the present invention have the following beneficial effects:
The present invention provides a method for processing train interface data of hot standby on-board equipment, a second main control unit is used for hot backup of the first main control unit, power is supplied to the first main control unit and the second main control unit concurrently, input signals of the first main control unit and the second main control unit from the train interface are controlled to maintain consistent, so as to ensure that the first main control unit and the second main control unit are synchronized in operation, so that when the first main control unit fails, an automatic switch can be made to the second main control unit without stopping the train.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] In order to more clearly illustrate the technical solutions in the embodiments of the present invention or in the prior art, the drawings necessary for description of the embodiments or the prior art will be briefly introduced below, obviously, the drawings in the following description are just some embodiments of the present invention, other drawings can be obtained by those of ordinary skill in the art based on these drawings without paying creative efforts. Figs. 1 and 2 show configurations having some but not all features of claim 1. Any passages in the following text referring to the configurations of figs. 1 and 2 and containing statements regarding embodiments of the invention are meant to be understood as discussing or showing parts of an embodiment of the invention which is consistent with the scope of claim 1 even though not all the features of claim 1 are discussed or shown.

FIG. 1 is a schematic diagram of signal transmission between the hot standby on-board equipment and the train interface of the present invention;
FIG. 2 is a block diagram of overall flowchart of the method for processing train interface data of hot standby on-board equipment of the present invention;
FIG. 3 is a block diagram of flowchart of Scheme 1 in the case where the input signals are maintained consistent;
FIG. 4 is a block diagram of flowchart of Scheme 2 in the case where the input signals are maintained consistent;
FIG. 5 is a block diagram of partial flowchart for Situation 3 in Scheme 2 adopted in the processing measures for the brake command;
FIG. 6 is a block diagram of partial flowchart for Situation 3 in Scheme 2 adopted in the processing measures for the brake command;
FIG. 7 is a block diagram of partial flowchart for Sit-

uation 3 in Scheme 2 adopted in the processing measures for the brake command;
FIG. 8 is a block diagram of partial flowchart for Situation 3 in Scheme 2 adopted in the processing measures for the brake command;
FIG. 9 is a block diagram of partial flowchart for Situation 3 in Scheme 2 adopted in the processing measures for the traction removing command;
FIG. 10 is a block diagram of partial flowchart for Situation 3 in Scheme 2 adopted in the processing measures for the traction removing command;
FIG. 11 is a block diagram of partial flowchart for Situation 3 in Scheme 2 adopted in the processing measures for the traction removing command;
FIG. 12 is a block diagram of partial flowchart for Situation 3 in Scheme 2 adopted in the processing measures for the traction removing command;
FIG. 13 is a flowchart of the brake test of on-board equipment.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0019] In order to make the objects, technical solutions and advantages of the embodiments of the present invention more clear, the technical solutions in the embodiments of the present invention will be described clearly and completely in conjunction with the accompanying drawings in the embodiments of the present invention, obviously, the described embodiments are only part of the embodiments of the present invention, not all the embodiments.

[0020] In the embodiment of the present invention, the first main control unit may be a main system main control unit or a standby system main control unit, and the second main control unit may be a main system main control unit or a standby system main control unit, that is, the first main control unit and the second main control unit are mutual backup for each other, wherein the second main control unit is the standby system main control unit when the first main control unit is the main system main control unit, the first main control unit is the standby system main control unit when the second main control unit is the main system main control unit.

[0021] As shown in FIG. 1, it is a schematic diagram of signal transmission between the hot standby on-board equipment and the train interface of this embodiment, the hot standby on-board equipment includes a first main control unit and a second main control unit, the first main control unit and the second main control unit receive input signals transmitted by the train interface, and the first main control unit and the second main control unit transmit output signals to the train interface.

[0022] As shown in FIG. 2, it is the method for processing train interface data of hot standby on-board equipment of this embodiment, which specifically comprises: the second main control unit performs hot backup with respect to the first main control unit, power is supplied to the first main control unit and the second main control unit concurrently.

[0023] Regarding the input signals transmitted by the train interface, the first main control unit and the second main control unit process the input signals transmitted by the train interface, input signals of the first main control unit and the second main control unit from train the interface are controlled to maintain consistent.

[0024] Accordingly, the first main control unit and the second main control unit are made to maintain completely synchronized in operation, so that when the first main control unit fails, an automatic switch can be made to the second main control unit without stopping the train.

[0025] The input signals include, but not limited to, an activation state of a cab console, a position of a steering handle and a sleep signal;

[0026] Concurrently supplying power to the first main control unit and the second main control unit as described above specifically is: separate power supply modules may be used to concurrently supply power to the first main control unit and the second main control unit, or the same power supply module may be used to synchronously supply power to the first main control unit and the second main control unit.

[0027] Maintaining the input signals of the first main control unit and the second main control unit to be consistent as described above may be implemented specifically by adopting the following two schemes.

[0028] Scheme 1, as shown in FIG. 3:

S1: the first main control unit receives a current first input signal, and the second main control unit receives a current second input signal;
S2: the first main control unit transmits the first input signal to the second main control unit;
S3: the second main control unit compares signal content of the first input signal and signal content of the second input signal; if signal contents thereof are consistent, the first main control unit is notified to use the currently collected first input signal as input and the second main control unit is notified to use the currently collected second input signal as input; if signal contents thereof are inconsistent, the first main control unit is notified to discard the first input signal and the second main control unit is notified to discard the second input signal, the first main control unit and the second main control unit maintain previous consistent signals as input.

[0029] It should be noted that the "signal contents being consistent" here refers to commands being consistent. Taking signal activation as an example, the first main control unit and the second main control unit simultaneously receive an activation signal transmitted by the train interface or simultaneously receive a non-activation signal transmitted by the train interface, it means that the signal contents are consistent.

[0030] As a preferred way, in Scheme 1, in the case where signal contents of the first input signal and the

second input signal are inconsistent, if signal contents of the first input signal and the second input signal are inconsistent for too long, exceeding a set time length, the second main control unit determines that the first main control unit and the second main control unit are not synchronized in operation, the second main control unit is controlled to enter a fault mode, the first main control unit continues to operate.

[0031] Scheme 2, as shown in FIG. 4:
the first main control unit receives the current input signal, and then transmits the input signal to the second main control unit; the second main control unit receives the input signal transmitted by the first main control unit, and uses the received input signal as its own input signal.

[0032] Regarding the output signal transmitted to the train interface, when the second main control unit makes hot backup with respect to the first main control unit and power is supplied to the first main control unit and the second main control unit concurrently, in order to ensure driving safety, different situations need to be addressed so as to determine the transmission measures to be taken to transmit the signal.

[0033] The output signal includes a safety command, the safety command includes a speed control command, the speed control command includes, but not limited to, a braking command, the braking command includes, but not limited to, an emergency braking command and a full service breaking command.

[0034] Processing measures of the speed control command are determined respectively for different situations below, and the braking command is taken as an example for description.

[0035] Situation 1:
when the on-board equipment loses power, or the first main control unit and the second main control unit both fail, the on-board equipment transmits a braking command to the train interface.

[0036] Situation 2:
when at least one of the first main control unit and the second main control unit is in a normal operating state, the on-board equipment determines whether to transmit a braking command to the train interface or cancel transmitting a braking command to the train interface according to an operating situation

[0037] The "operating condition" here includes three situations where the first main control unit fails or has no power, the second main control unit fails or has no power, and the first main control unit and the second main control unit both operate normally.

[0038] In Situation 2, the following two schemes are specifically adopted:

Scheme 1:

[0039] Scheme 1 includes processing of the following three cases:

Case 1: the first main control unit fails or has no power, the second main control unit determines whether to transmit a braking command to the train interface or to cancel transmitting a braking command to the train interface as required, for example, the second main control unit transmits a braking command to the train interface in the case where the train drives over a speed limit, the second main control unit does not transmit a braking command to the train interface when the train does not drive over a speed limit;
Case 2: the second main control unit fails or has no power, the first main control unit determines whether to transmit a braking command to the train interface or to cancel transmitting a braking command to the train interface as required, the example scenario of "as required" is as above;
Case 3: the first main control unit and the second main control unit are both normally operating, the second main control unit continues to transmit a braking command to a circuit module within the on-board equipment;

the first main control unit determines whether to transmit a braking command to the circuit module or to cancel transmitting a braking command to the circuit module as required, the example scenario of "as required" is as above;
if the circuit module receives the braking command of the second main control unit and the braking command of the first main control unit, it transmits a braking command to the train interface;
if the circuit module only receives the braking command of the second main control unit, it cancels transmitting the braking command to the train interface.

Scheme 2:

[0040] Scheme 2 includes processing of the following three cases:

Case 1: the first main control unit fails or has no power, the second main control unit determines whether to transmit a braking command to the train interface or to cancel transmitting a braking command to the train interface as required, the example scenario of "as required" is as above;
Case 2: the second main control unit fails or has no power, the first main control unit determines whether to transmit a braking command to the train interface or to cancel transmitting a braking command to the train interface as required, the example scenario of "as required" is as above;
Case 3: the first main control unit and the second main control unit are both normally operating, the first main control unit or the second main control unit determines whether to transmit a braking command to the train interface or to cancel transmitting a brak-

ing command to the train interface according to states of a local end and a peer end, the specific processing is provided below.

T1: as shown in FIG. 5, initially, both the local end and the peer end are in an idle state; "both the local end and the peer end are in an idle state" means that the local end and the peer end remain in the same state, that is, the local end and the peer end are in the state of transmitting the brake command at the same time, or the local end and the peer end are in the state of cancelling transmitting the brake state at the same time;

T2: when the local end transmits a braking command to the train interface, it is determined whether a transmitting state of the braking command changes; in the case where the transmitting state of the braking command changes, a first timer is started, a state of monitoring a peer end is entered, then step T3 is executed; in the case where a transmitting state of the braking command does not change, it continues to determine whether braking command information of the peer end is received, if braking command information of the peer end is received, an acknowledgement packet of having received the braking command information is transmitted to the peer end, and a second timer is started, a state of monitoring the local end is entered, then step T4 is executed; if no braking command information of the peer end is received, it continues to determine whether the transmitting state of the braking command of the local end changes when the local end transmits a braking command to the train interface;

T3: it is determined whether the changed transmitting state of the braking command is to transmit a braking command to the train interface or to cancel transmitting a braking command to the train interface; if the changed transmitting state of the braking command is to transmit a braking command to the train interface, the local end transmits a braking command to the train interface and periodically transmits, to the peer end, information for transmitting a braking command to the train interface, it continues to execute step T3-1; if the changed braking command transmitting state is to cancel transmitting a braking command to the train interface, the local end cancels transmitting a braking command to the train interface temporarily, and periodically transmits, to the peer end, information for cancelling transmitting a braking command to the train interface, it continues to execute step T3-2;

T3-1: as shown in FIG. 6, it is determined whether braking command information of the peer end is received; if braking command information of the peer end is received, an acknowledgement packet of having received the braking command information is transmitted to the peer end, and it is determined whether the braking command information of the peer end and the changed transmitting state of the braking command of the local end are consistent; if the braking command information of the peer end and the changed transmitting state of the braking command of the local end are consistent, the first timer is closed, the local end enters an idle state; if the braking command information of the peer end and the changed transmitting state of the braking command of the local end are inconsistent, the local end enters a fault state; if no braking command information of the peer end is received, it is determined whether timing of the first timer expires; if timing of the first timer expires, the first timer is closed, the local end enters the idle state; if timing of the first timer does not expire, it is determined whether an acknowledgement packet for braking command information of the peer end is received; if an acknowledgement packet for braking command information of the peer end is received, it stops transmitting, to the peer end, information for transmitting braking command information to the train interface, a current state is maintained; if no acknowledgement packet for braking command information of the peer end is received, it is determined whether the information for transmitting braking command information to the train interface has been transmitted to the peer end for more than a specified number of times; if the information for transmitting braking command information to the train interface has been transmitted to the peer end for more than the specified number of times, it stops transmitting, to the peer end, information for transmitting braking command information to the train interface, and the local end enters a fault state; if the information for transmitting braking command information to the train interface has not been transmitted to the peer end for more than the specified number of times, it continues to transmit, to the peer end, information for transmitting braking command information to the train interface;

T3-2: as shown in FIG. 7, it is determined whether braking command information of the peer end is received; if braking command information of the peer end is received, an acknowledgement packet of having received the braking command information is transmitted to the peer end, and it is determined whether the braking command information of the peer end and the changed transmitting state of the braking command of the local end are consistent; if the braking command information of the peer end and the changed transmitting state of the braking command of the local end are consistent, the first timer is closed, the local end enters an idle state; if the braking command information of the peer end and the changed transmitting state of the braking command of the local end are inconsistent, the local end enters a fault state; if no braking command information of the peer end is received, it is determined whether timing of the first timer expires; if timing of

the first timer expires, the first timer is closed, the local end enters the idle state; if timing of the first timer does not expire, it is determined whether an acknowledgement packet for braking command information of the peer end is received; if an acknowledgement packet for braking command information of the peer end is received, it stops transmitting, to the peer end, information for cancelling transmitting braking command information to the train interface, a current state is maintained; if no acknowledgement packet for braking command information of the peer end is received, it is determined whether the information for cancelling transmitting braking command information to the train interface has been transmitted to the peer end for more than a specified number of times; if the information for cancelling transmitting braking command information to the train interface has been transmitted to the peer end for more than the specified number of times, it stops transmitting, to the peer end, information for transmitting braking command information to the train interface, and the local end enters a fault state; if the information for cancelling transmitting braking command information to the train interface has not been transmitted to the peer end for more than the specified number of times, it continues to transmit, to the peer end, information for cancelling transmitting braking command information to the train interface;

T4: as shown in FIG. 8, when the local end transmits a braking command to the train interface, it is determined whether a transmitting state of the braking command changes; in the case where the transmitting state of the braking command changes, it is determined whether the changed transmitting state of the braking command of the local end is consistent with the braking command information of the peer end as received; if the changed transmitting state of the braking command of the local end is consistent with the braking command information of the peer end as received, the local end maintains the changed transmitting state of the braking command, and transmits the changed braking command information to the peer end, the second timer is turned off, it enters a state of waiting for acknowledgement from the peer end, it continues to execute step T5; if the changed transmitting state of the braking command is inconsistent with the braking command information of the peer as received, the second timer is closed, the local end enters a fault state; if the transmitting state of the braking command does not change, it is determined whether the second timer expires; if the second timer expires, the second timer is closed, it enters a fault state; if the second timer does not expire, it continues to determine whether a transmitting state of the braking command changes when the local end transmits a braking command to the train interface;

T5: the changed braking command information is transmitted to the peer end periodically, it is determined whether acknowledgement information about the braking command of the peer end is received; if acknowledgement information about the braking command of the peer end is received, the local end enters an idle state; if no acknowledgement information about the braking command of the peer end is received, it is determined whether the number of times of transmitting the changed braking command information to the peer end exceeds the specified number of times; if the number of times of transmitting the changed braking command information to the peer end exceeds the specified number of times, the local end enters an idle state; if the number of times of transmitting the changed braking command information to the peer end does not exceed the specified number of times, it continues to transmit the changed braking command information to the peer end.

[0041] The safety command further includes a traction removing command, processing measures of the traction removing command are determined respectively for different situations below.

[0042] Situation 1:

when the on-board equipment loses power, or the first main control unit and the second main control unit both fail, the on-board equipment transmits a traction removing command to the train interface.

[0043] Situation 2:

when at least one of the first main control unit and the second main control unit is in a normal operating state, the on-board equipment determines whether to transmit a traction removing command to the train interface or cancel transmitting a traction removing command to the train interface according to an operating situation

[0044] The "operating condition" here includes three situations where the first main control unit fails or has no power, the second main control unit fails or has no power, and the first main control unit and the second main control unit both operate normally.

[0045] In Situation 2, the following two schemes are specifically adopted:

Scheme 1:

[0046] Scheme 1 includes processing of the following three cases:

Case 1: the first main control unit fails or has no power, the second main control unit determines whether to transmit a traction removing command to the train interface or to cancel transmitting a traction removing command to the train interface as required, for example, the second main control unit transmits a traction removing command to the train interface in the case where the train drives over a speed limit, the second main control unit does not transmit a traction

removing command to the train interface when the train does not drive over a speed limit;
Case 2: the second main control unit fails or has no power, the first main control unit determines whether to transmit a traction removing command to the train interface or to cancel transmitting a traction removing command to the train interface as required, the example scenario of "as required" is as above;
Case 3: the first main control unit and the second main control unit are both normally operating, the second main control unit continues to transmit a traction removing command to a circuit module within the on-board equipment;

the first main control unit determines whether to transmit a traction removing command to the circuit module or to cancel transmitting a traction removing command to the circuit module as required, the example scenario of "as required" is as above;
if the circuit module receives the traction removing command of the second main control unit and the traction removing command of the first main control unit, it transmits a traction removing command to the train interface;
if the circuit module only receives the traction removing command of the second main control unit, it cancels transmitting the traction removing command to the train interface.

Scheme 2:

[0047] Scheme 2 includes processing of the following three cases:

Case 1: the first main control unit fails or has no power, the second main control unit determines whether to transmit a traction removing command to the train interface or to cancel transmitting a traction removing command to the train interface as required, the example scenario of "as required" is as above;
Case 2: the second main control unit fails or has no power, the first main control unit determines whether to transmit a traction removing command to the train interface or to cancel transmitting a traction removing command to the train interface as required, the example scenario of "as required" is as above;
Case 3: the first main control unit and the second main control unit are both normally operating, the first main control unit or the second main control unit determines whether to transmit a traction removing command to the train interface or to cancel transmitting a traction removing command to the train interface according to states of a local end and a peer end, the specific processing is provided below.

P1: as shown in FIG. 9, initially, both the local end and the peer end are in an idle state; "both the local end and the peer end are in an idle state" means that the local end and the peer end remain in the same state, that is, the local end and the peer end are in the state of transmitting a traction removing command at the same time, or the local end and the peer end are in the state of cancelling transmitting a traction removing command at the same time;
P2: when the local end transmits a traction removing command to the train interface, it is determined whether a transmitting state of the traction removing command changes; in the case where the transmitting state of the traction removing command changes, a first timer is started, a state of monitoring a peer end is entered, then step P3 is executed; in the case where a transmitting state of the traction removing command does not change, it is determined whether traction removing command information of the peer end is received, if traction removing command information of the peer end is received, a second timer is started, a state of monitoring the local end is entered, then step P4 is executed; if no traction removing command information of the peer end is received, it continues to determine whether the transmitting state of the traction removing command of the local end changes when the local end transmits a traction removing command to the train interface;
P3: it is determined whether the transmitting state of a changed traction removing command is to transmit a traction removing command to the train interface or to cancel transmitting a traction removing command to the train interface; if the transmitting state of the changed traction removing command is to transmit a traction removing command to the train interface, the local end transmits a traction removing command to the train interface and periodically transmits, to the peer end, information for transmitting a traction removing command to the train interface, it continues to execute step P3-1; if the changed traction removing command transmitting state is to cancel transmitting a traction removing command to the train interface, the local end cancels transmitting a traction removing command to the train interface temporarily, and periodically transmits, to the peer end, information for cancelling transmitting a traction removing command to the train interface, it continues to execute step P3-2;
P3-1: as shown in FIG. 10, it is determined whether traction removing command information of the peer end is received; if traction removing command information of the peer end is received, an acknowledgement packet of having received the traction removing command information is transmitted to the peer end, and it is determined whether the traction removing command information of the peer end and the transmitting state of the changed traction removing command of the local end are consistent; if the traction removing command information of the peer end and the transmitting state of the changed traction remov-

ing command of the local end are consistent, the first timer is closed, the local end enters an idle state; if the traction removing command information of the peer end and the transmitting state of the changed traction removing command of the local end are inconsistent, the local end enters a fault state; if no traction removing command information of the peer end is received, it is determined whether timing of the first timer expires; if timing of the first timer expires, the first timer is closed, the local end enters the idle state; if timing of the first timer does not expire, it is determined whether an acknowledgement packet for traction removing command information of the peer end is received; if an acknowledgement packet for traction removing command information of the peer end is received, it stops transmitting, to the peer end, information for transmitting traction removing command information to the train interface, a current state is maintained; if no acknowledgement packet for traction removing command information of the peer end is received, it is determined whether the information for transmitting traction removing command information to the train interface has been transmitted to the peer end for more than a specified number of times; if the information for transmitting traction removing command information to the train interface has been transmitted to the peer end for more than the specified number of times, it stops transmitting, to the peer end, information for transmitting traction removing command information to the train interface, and the local end enters a fault state; if the information for transmitting traction removing command information to the train interface has not been transmitted to the peer end for more than the specified number of times, it continues to transmit, to the peer end, information for transmitting traction removing command information to the train interface;

P3-2: as shown in FIG. 11, it is determined whether traction removing command information of the peer end is received; if traction removing command information of the peer end is received, an acknowledgement packet of having received the traction removing command information is transmitted to the peer end, and it is determined whether the traction removing command information of the peer end and the transmitting state of the changed traction removing command of the local end are consistent; if the traction removing command information of the peer end and the transmitting state of the changed traction removing command of the local end are consistent, the first timer is closed, the local end enters an idle state; if the traction removing command information of the peer end and the transmitting state of the changed traction removing command of the local end are inconsistent, the local end enters a fault state; if no traction removing command information of the peer end is received, it is determined whether timing of the first timer expires; if timing of the first timer expires, the first timer is closed, the local end enters the idle state; if timing of the first timer does not expire, it is determined whether an acknowledgement packet for traction removing command information of the peer end is received; if an acknowledgement packet for traction removing command information of the peer end is received, it stops transmitting, to the peer end, information for cancelling transmitting traction removing command information to the train interface, a current state is maintained; if no acknowledgement packet for traction removing command information of the peer end is received, it is determined whether the information for cancelling transmitting traction removing command information to the train interface has been transmitted to the peer end for more than a specified number of times; if the information for cancelling transmitting traction removing command information to the train interface has been transmitted to the peer end for more than the specified number of times, it stops transmitting, to the peer end, information for transmitting traction removing command information to the train interface, and the local end enters a fault state; if the information for cancelling transmitting traction removing command information to the train interface has not been transmitted to the peer end for more than the specified number of times, it continues to transmit, to the peer end, information for cancelling transmitting traction removing command information to the train interface;

P4: as shown in FIG. 12, when the local end transmits a traction removing command to the train interface, it is determined whether a transmitting state of the traction removing command changes; in the case where the transmitting state of the traction removing command changes, it is determined whether the transmitting state of the changed traction removing command of the local end is consistent with the traction removing command information of the peer end as received; if the transmitting state of the changed traction removing command of the local end is consistent with the traction removing command information of the peer end as received, the local end maintains the transmitting state of the changed traction removing command, and transmits the changed traction removing command information to the peer end, the second timer is turned off, it enters a state of waiting for acknowledgement from the peer end, it continues to execute step P5; if the transmitting state of the changed traction removing command is inconsistent with the traction removing command information of the peer as received, the second timer is closed, the local end enters a fault state; if the transmitting state of the traction removing command does not change, it is determined whether the second timer expires; if the second timer expires, the second timer is closed, it enters a fault state; if the

second timer does not expire, it continues to determine whether a transmitting state of the traction removing command changes when the local end transmits a traction removing command to the train interface;

P5: the changed traction removing command information is transmitted to the peer end periodically, it is determined whether acknowledgement information about the traction removing command of the peer end is received; if acknowledgement information about the traction removing command of the peer end is received, the local end enters an idle state; if no acknowledgement information about the traction removing command of the peer end is received, it is determined whether the number of times of transmitting the changed traction removing command information to the peer end exceeds the specified number of times; if the number of times of transmitting the changed traction removing command information to the peer end exceeds the specified number of times, the local end enter an idle state; if the number of times of transmitting the changed traction removing command information to the peer end does not exceed the specified number of times, it continues to transmit the changed traction removing command information to the peer end.

[0048] The safety command further includes a train interface control command, the train interface control command includes, but not limited to, service breaking level 4, a routine brake level 1, Passing Neutral Section command, Passing Neutral Section selection;

[0049] Processing measures of the train interface control command are determined respectively for different situations below, description is provided with the Passing Neutral Section command as an example.

[0050] Situation 1:

when the on-board equipment loses power, or the first main control unit and the second main control unit both fail, transmitting a Passing Neutral Section command to the train interface is cancelled.

[0051] Situation 2:

when at least one of the first main control unit and the second main control unit is in a normal operating state, the on-board equipment determines whether to transmit a Passing Neutral Section command to the train interface according to an operating situation;

[0052] The "operating condition" here includes three situations where the first main control unit fails or has no power, the second main control unit fails or has no power, and the first main control unit and the second main control unit both operate normally.

[0053] The above Situation 2 specifically includes processing of the following three cases:

Case 1: the first main control unit fails or has no power, the first main control unit continues to cancel transmitting a Passing Neutral Section command to the train interface, the second main control unit determines whether to transmit a Passing Neutral Section command to the train interface as required, for example, the second main control unit transmits a Passing Neutral Section command to the train interface in a railway section that needs to execute a Passing Neutral Section command, the second main control unit does not transmit a Passing Neutral Section command to the train interface in a railway section that does not need to execute a Passing Neutral Section command;

Case 2: the second main control unit fails or has no power, the second main control unit continues to cancel transmitting a Passing Neutral Section command to the train interface, the first main control unit determines whether to transmit a Passing Neutral Section command to the train interface as required, the example scenario of "as required" is as above;

Case 3: the first main control unit and the second main control unit are both normally operating, the second main control unit continues to transmit a Passing Neutral Section command to a circuit module within the on-board equipment;

the first main control unit determines whether to transmit a Passing Neutral Section command to the circuit module or to cancel transmitting a Passing Neutral Section command to the circuit module as required, the example scenario of "as required" is as above;

if the circuit module does not receive a Passing Neutral Section command, transmitting a Passing Neutral Section command to the train interface is cancelled;

if the circuit module receives a Passing Neutral Section command of the first main control unit, it transmits a Passing Neutral Section command to the train interface.

[0054] When the existing on-board equipment is started, the brake loop needs to be tested to ensure that the braking command is accurately transmitted during operation. Therefore, the second main control unit performs hot backup with respect to the first main control unit, in the case where power is supplied to the first main control unit and the second main control unit concurrently, a method for brake test of the vehicle equipment is provided, the method specifically comprises the following steps, as shown in FIG. 13.

D1: the first main control unit receives a brake test request in real time, after the first main control unit receives a brake test request, the first main control unit starts to perform a brake test; if the brake test fails, a driver is reminded of that the brake test fails, the brake test is re-executed until the brake test is successful; if the brake test is successful, the second main control unit is instructed to perform a brake test;

D2: after the second main control unit receives a command of performing a brake test transmitted by the first main control unit, it transmits a command receipt acknowledgement to the first main control unit, the second main control unit starts to perform a brake test; if the brake test is successful, a brake test result is transmitted to the first main control unit, the first main control unit feeds back brake test results of the local end and the second main control unit to the driver;
if the brake test fails, it is determined whether the number of times of braking test exceeds a specified number of times, step D3 is executed in the case where it does not exceed, step D4 is executed in the case where it exceeds;
D3: the brake test is repeated until the brake test is successful, thereafter the brake test result is transmitted to the first main control unit, the first main control unit feeds back the brake test results of the local end and the second main control unit to the driver;
D4: the first main control unit is informed of test end, the second main control unit enters a fault state; after the first main control unit receives a test end message of the second main control unit, it will feed back the brake test result of the first main control unit to the driver.

[0055] Using the above method, when the on-board equipment is started, the braking loops of the first main control unit and the second main control unit are tested, so as to ensure that the braking command is accurately transmitted during the operation of the on-board equipment.

Claims

1. A method for processing train interface data for a hot standby on-board equipment, wherein

a second main control unit is used for hot backup of a first main control unit, power is supplied to the first main control unit and the second main control unit concurrently;
the first main control unit and the second main control unit receive input signals transmitted by a train interface, and control the input signals to be consistent;
when the on-board equipment loses power, or the first main control unit and the second main control unit both fail, the on-board equipment transmits a safety command to the train interface;
when at least one of the first main control unit and the second main control unit is in a normal operating state, the on-board equipment determines whether to transmit the safety command to the train interface according to an operating situation;
characterized in that
when the first main control unit and the second main control unit are both operating normally, the first main control unit or the second main control unit determines whether to transmit the safety command to the train interface according to a state of a local end and a state of a peer end, comprising:

T1: initially, both the local end and the peer end are in an idle state;
T2: when the local end transmits the safety command to the train interface, it is determined whether a transmitting state of the safety command changes; in the case where the transmitting state of the safety command changes, a first timer is started, a state of monitoring the peer end is entered, step T3 is executed; in the case where the transmitting state of the safety command does not change, it is determined whether safety command information of the peer end is received, if the safety command information of the peer end is received, an acknowledgement packet of having received the safety command information is transmitted to the peer end, and a second timer is started, a state of monitoring the local end is entered, step T4 is executed; if no safety command information of the peer end is received, it continues to determine whether the transmitting state of the safety command of the local end changes;
T3: it is determined whether the changed transmitting state of the safety command is to transmit the safety command to the train interface; if the changed transmitting state of the safety command is transmitting the safety command to the train interface, the local end transmits the safety command to the train interface and periodically transmits, to the peer end, information for transmitting the safety command to the train interface, it continues to execute step T3-1; if the changed transmitting state of the safety command is not transmitting the safety command to the train interface, the local end will not transmit the safety command to the train interface, and periodically transmits, to the peer end, information for not transmitting the safety command to the train interface, it continues to execute step T3-2;
T3-1: it is determined whether the safety command information of the peer end is received; if the safety command information of the peer end is received, an acknowledgement packet of having received the

safety command information is transmitted to the peer end, and it is determined whether the safety command information of the peer end and the changed transmitting state of the safety command of the local end are consistent; if the safety command information of the peer end and the changed transmitting state of the safety command of the local end are consistent, the first timer is closed, the local end enters an idle state; if the safety command information of the peer end and the changed transmitting state of the safety command of the local end are inconsistent, the local end enters a fault state; if no safety command information of the peer end is received, it is determined whether timing of the first timer expires; if timing of the first timer expires, the first timer is closed, the local end enters the idle state; if timing of the first timer does not expire, it is determined whether an acknowledgement packet for safety command information of the peer end is received; if the acknowledgement packet for safety command information of the peer end is received, it stops transmitting, to the peer end, information for transmitting safety command information to the train interface, a current state is maintained; if no acknowledgement packet for safety command information of the peer end is received, it is determined whether the information for transmitting safety command information to the train interface has been transmitted to the peer end for more than a specified number of times; if the information for transmitting safety command information to the train interface has been transmitted to the peer end for more than the specified number of times, it stops transmitting, to the peer end, information for transmitting safety command information to the train interface, and the local end enters a fault state; if the information for transmitting safety command information to the train interface has not been transmitted to the peer end for more than the specified number of times, it continues to transmit, to the peer end, information for transmitting safety command information to the train interface;

T3-2: it is determined whether the safety command information of the peer end is received; if the safety command information of the peer end is received, an acknowledgement packet of having received the safety command information is transmitted to the peer end, and it is determined whether the safety command information of the peer end and the changed transmitting state of the safety command of the local end are consistent; if the safety command information of the peer end and the changed transmitting state of the safety command of the local end are consistent, the first timer is closed, the local end enters an idle state; if the safety command information of the peer end and the changed transmitting state of the safety command of the local end are inconsistent, the local end enters a fault state; if no safety command information of the peer end is received, it is determined whether timing of the first timer expires; if timing of the first timer expires, the first timer is closed, the local end enters the idle state; if timing of the first timer does not expire, it is determined whether an acknowledgement packet for safety command information of the peer end is received; if the acknowledgement packet for safety command information of the peer end is received, it stops transmitting, to the peer end, information for not transmitting safety command information to the train interface, a current state is maintained; if no acknowledgement packet for safety command information of the peer end is received, it is determined whether the information for not transmitting safety command information to the train interface has been transmitted to the peer end for more than a specified number of times; if the information for not transmitting safety command information to the train interface has been transmitted to the peer end for more than the specified number of times, it stops transmitting, to the peer end, information for transmitting safety command information to the train interface, and the local end enters a fault state; if the information for not transmitting safety command information to the train interface has not been transmitted to the peer end for more than the specified number of times, it continues to transmit, to the peer end, information for not transmitting safety command information to the train interface;

T4: when the local end transmits the safety command to the train interface, it is determined whether the transmitting state of the safety command changes; in the case where the transmitting state of the safety command changes, it is determined whether the changed transmitting state of the safety command of the local end is consistent with the safety command information of the peer end as received; if the changed transmitting state of the safety command of the local end is consistent with the safety

command information of the peer end as received, the local end maintains the changed transmitting state of the safety command, and transmits the changed safety command information to the peer end, the second timer is turned off, it enters a state of waiting for acknowledgement from the peer end, it continues to execute step T5; if the changed transmitting state of the safety command is inconsistent with the safety command information of the peer as received, the second timer is closed, the local end enters a fault state; if the answer is negative, it is determined whether the second timer expires; if the second timer expires, the second timer is closed, it enters a fault state; if the second timer does not expire, it continues to determine whether the transmitting state of the safety command changes when the local end transmits the safety command to the train interface;

T5: the changed safety command information is transmitted to the peer end periodically, it is determined whether acknowledgement information about the safety command of the peer end is received; if acknowledgement information about the safety command of the peer end is received, the local end enters an idle state; if no acknowledgement information about the safety command of the peer end is received, it is determined whether the number of times of transmitting the changed safety command information to the peer end exceeds a specified number of times; if the number of times of transmitting the changed safety command information to the peer end exceeds the specified number of times, the local end enters an idle state; if the number of times of transmitting the changed safety command information to the peer end does not exceed the specified number of times, it continues to transmit the changed safety command information to the peer end.

2. The method for processing train interface data for the hot standby on-board equipment according to claim 1, wherein controlling the input signals to be consistent specifically comprises the following steps:

S 1: the second main control unit receives a currently collected first input signal transmitted by the first main control unit;

S2: the second main control unit compares the first input signal with a currently collected second input signal; if signal content of the first input signal and signal content of the second input signal are consistent, the first main control unit uses the currently collected first input signal as input and the second main control unit uses the currently collected second input signal as input; if signal content of the first input signal and signal content of the second input signal are inconsistent, the first main control unit discards the first input signal and the second main control unit discards the second input signal, the first main control unit and the second main control unit remain using previous consistent signals as input.

3. The method for processing train interface data for the hot standby on-board equipment according to claim 2, wherein when signal content of the first input signal and signal content of the second input signal are inconsistent, it is determined that the second main control unit fails if a time period for which signal content of the first input signal and signal content of the second input signal are inconsistent exceeds a prescribed time period.

4. The method for processing train interface data for the hot standby on-board equipment according to claim 1, wherein controlling the input signals to be consistent is specifically:

the first main control unit receives a current input signal, and transmits the input signal to the second main control unit;

the second main control unit receives the input signal as its own input signal.

5. The method for processing train interface data for the hot standby on-board equipment according to claim 1, wherein the safety command includes a speed control command and a traction removing command.

6. The method for processing train interface data for the hot standby on-board equipment according to claim 1, wherein the method further comprises a brake test of the on-board equipment, and the brake test comprises the following steps:

D1: after the first main control unit receives a brake test request, a brake test is performed; if the brake test fails, a driver is reminded of that the brake test fails, the brake test is re-executed until the brake test is successful; if the brake test is successful, the second main control unit is instructed to perform a brake test;

D2: after the second main control unit receives the command and transmits a command receipt acknowledgement to the first main control unit, the second main control unit starts to perform a brake test; if the brake test is successful, a brake test result is transmitted to the first main control unit, the first main control unit feeds back brake

test results of the local end and the second main control unit to the driver;
if the brake test fails, it is determined whether the number of times of braking exceeds a specified number of times, step D3 is executed in the case where it exceeds, step D4 is executed in the case where it does not exceed;
D3: the brake test is repeated until the brake test is successful, thereafter the brake test result is transmitted to the first main control unit, the first main control unit feeds back the brake test results of the local end and the second main control unit to the driver;
D4: the first main control unit is informed of test end, the second main control unit enters a fault state; after the first main control unit receives a test end message of the second main control unit, it will feed back the brake test result of the first main control unit to the driver.

Patentansprüche

1. Verfahren zum Verarbeiten von Zugschnittstellendaten für eine Hot-Standby-Bordausrüstung, wobei

ein zweites Hauptsteuergerät für ein Hot-Backup eines ersten Hauptsteuergeräts verwendet wird, wobei dem ersten Hauptsteuergerät und dem zweiten Hauptsteuergerät gleichzeitig Strom zugeführt wird;
das erste Hauptsteuergerät und das zweite Hauptsteuergerät Eingangssignale empfangen, die von einer Zugschnittstelle übertragen werden, und die Eingangssignale steuern, um konsistent zu sein;
wenn die Bordausrüstung Leistung verliert oder das erste Hauptsteuergerät und das zweite Hauptsteuergerät beide ausfallen, die Bordausrüstung einen Sicherheitsbefehl an die Zugschnittstelle überträgt;
wenn mindestens eines von dem ersten Hauptsteuergerät und dem zweiten Hauptsteuergerät in einem normalen Betriebszustand ist, die Bordausrüstung gemäß einer Betriebssituation bestimmt, ob der Sicherheitsbefehl an die Zugschnittstelle übertragen werden soll;
dadurch gekennzeichnet, dass
wenn das erste Hauptsteuergerät und das zweite Hauptsteuergerät beide normal arbeiten, das erste Hauptsteuergerät oder das zweite Hauptsteuergerät bestimmt, ob der Sicherheitsbefehl gemäß einem Zustand einer lokalen Seite und einem Zustand einer Gegenseite an die Zugschnittstelle übertragen werden soll, umfassend:

T1: anfangs sind sowohl die lokale Seite als auch die Gegenseite in einem Ruhezustand;
T2: wenn die lokale Seite den Sicherheitsbefehl an die Zugschnittstelle überträgt, wird bestimmt, ob sich ein Übertragungszustand des Sicherheitsbefehls ändert; wenn sich der Übertragungszustand des Sicherheitsbefehls ändert, wird ein erster Zeitgeber gestartet, es wird in einen Überwachungszustand der Gegenseite übergegangen, Schritt T3 wird ausgeführt; wenn sich der Übertragungszustand des Sicherheitsbefehls nicht ändert, wird bestimmt, ob Sicherheitsbefehlsinformationen der Gegenseite empfangen werden, wenn die Sicherheitsbefehlsinformationen der Gegenseite empfangen werden, wird ein Bestätigungspaket, dass die Sicherheitsbefehlsinformationen empfangen wurden, an die Gegenseite übertragen, und ein zweiter Zeitgeber wird gestartet, es wird in einen Überwachungszustand der lokalen Seite übergegangen, Schritt T4 wird ausgeführt; wenn keine Sicherheitsbefehlsinformationen der Gegenseite empfangen werden, wird weiterhin bestimmt, ob sich der Übertragungszustand des Sicherheitsbefehls der lokalen Seite ändert;
T3: es wird bestimmt, ob der geänderte Übertragungszustand des Sicherheitsbefehls darin besteht, den Sicherheitsbefehl an die Zugschnittstelle zu übertragen; wenn der geänderte Übertragungszustand des Sicherheitsbefehls das Übertragen des Sicherheitsbefehls an die Zugschnittstelle ist, überträgt die lokale Seite den Sicherheitsbefehl an die Zugschnittstelle und überträgt periodisch, an die Gegenseite, Informationen zum Übertragen des Sicherheitsbefehls an die Zugschnittstelle und fährt mit der Ausführung von Schritt T3-1 fort; wenn der geänderte Übertragungszustand des Sicherheitsbefehls darin besteht, dass der Sicherheitsbefehl nicht an die Zugschnittstelle übertragen wird, überträgt die lokale Seite den Sicherheitsbefehl nicht an die Zugschnittstelle und überträgt periodisch, an die Gegenseite, Informationen zu einem Nichtübertragen des Sicherheitsbefehls an die Zugschnittstelle, es fährt mit der Ausführung von Schritt T3-2 fort;
T3-1: es wird bestimmt, ob die Sicherheitsbefehlsinformationen der Gegenseite empfangen werden; wenn die Sicherheitsbefehlsinformationen der Gegenseite empfangen werden, wird ein Bestätigungspaket, dass die Sicherheitsbefehlsinformationen empfangen wurden, an die Gegenseite

übertragen, und es wird bestimmt, ob die Sicherheitsbefehlsinformationen der Gegenseite und der geänderte Übertragungszustand des Sicherheitsbefehls der lokalen Seite konsistent sind; wenn die Sicherheitsbefehlsinformationen der Gegenseite und der geänderte Übertragungszustand des Sicherheitsbefehls der lokalen Seite übereinstimmen, wird der erste Zeitgeber beendet, die lokale Seite geht in einen Ruhezustand über; wenn die Sicherheitsbefehlsinformationen der Gegenseite und der geänderte Übertragungszustand des Sicherheitsbefehls der lokalen Seite nicht übereinstimmen, geht die lokale Seite in einen Fehlerzustand über; wenn keine Sicherheitsbefehlsinformationen der Gegenseite empfangen werden, es wird bestimmt, ob die Zeit des ersten Zeitgebers abläuft; wenn die Zeit des ersten Zeitgebers abläuft, wird der erste Zeitgeber beendet, die lokale Seite geht in den Ruhezustand über; wenn die Zeit des ersten Zeitgebers nicht abläuft, wird bestimmt, ob ein Bestätigungspaket für Sicherheitsbefehlsinformationen der Gegenseite empfangen wird; wenn das Bestätigungspaket für die Sicherheitsbefehlsinformationen der Gegenseite empfangen wird, stellt es die Übertragung von Informationen zum Übertragen von Sicherheitsbefehlsinformationen an die Zugschnittstelle an die Gegenseite ein, ein aktueller Zustand wird beibehalten; wenn kein Bestätigungspaket für Sicherheitsbefehlsinformationen der Gegenseite empfangen wird, wird bestimmt, ob die Informationen zum Übertragen von Sicherheitsbefehlsinformationen an die Zugschnittstelle mehr als eine spezifizierte Anzahl von Malen an die Gegenseite übertragen wurden; wenn die Informationen zum Übertragen von Sicherheitsbefehlsinformationen an die Zugschnittstelle mehr als die spezifizierte Anzahl von Malen an die Gegenseite übertragen wurden, wird ein Übertragen von Informationen zum Übertragen, an die Gegenseite, von Sicherheitsbefehlsinformationen an die Zugschnittstelle gestoppt, und die lokale Seite geht in einen Fehlerzustand über; wenn die Informationen zum Übertragen von Sicherheitsbefehlsinformationen an die Zugschnittstelle länger als die spezifizierte Anzahl von Malen nicht an die Gegenseite übertragen wurden, überträgt es weiterhin, an die Gegenseite, Informationen zum Übertragen von Sicherheitsbefehlsinformationen an die Zugschnittstelle;

T3-2: es wird bestimmt, ob die Sicherheitsbefehlsinformationen der Gegenseite empfangen werden; wenn die Sicherheitsbefehlsinformationen der Gegenseite empfangen werden, wird ein Bestätigungspaket, dass die Sicherheitsbefehlsinformationen empfangen wurden, an die Gegenseite übertragen, und es wird bestimmt, ob die Sicherheitsbefehlsinformationen der Gegenseite und der geänderte Übertragungszustand des Sicherheitsbefehls der lokalen Seite konsistent sind; wenn die Sicherheitsbefehlsinformationen der Gegenseite und der geänderte Übertragungszustand des Sicherheitsbefehls der lokalen Seite übereinstimmen, wird der erste Zeitgeber beendet, die lokale Seite geht in einen Ruhezustand über; wenn die Sicherheitsbefehlsinformationen der Gegenseite und der geänderte Übertragungszustand des Sicherheitsbefehls der lokalen Seite nicht übereinstimmen, geht die lokale Seite in einen Fehlerzustand über; wenn keine Sicherheitsbefehlsinformationen der Gegenseite empfangen werden, wird bestimmt, ob die Zeit des ersten Zeitgebers abläuft; wenn die Zeit des ersten Zeitgebers abläuft, wird der erste Zeitgeber beendet, die lokale Seite geht in den Ruhezustand über; wenn die Zeit des ersten Zeitgebers nicht abläuft, wird bestimmt, ob ein Bestätigungspaket für Sicherheitsbefehlsinformationen der Gegenseite empfangen wird; wenn das Bestätigungspaket für die Sicherheitsbefehlsinformationen der Gegenseite empfangen wird, stellt es die Übertragung von Informationen an die Gegenseite ein, um keine Sicherheitsbefehlsinformationen an die Zugschnittstelle zu übertragen, ein aktueller Zustand wird beibehalten; wenn kein Bestätigungspaket für die Sicherheitsbefehlsinformationen der Gegenseite empfangen wird, wird bestimmt, ob die Informationen, dass die Sicherheitsbefehlsinformationen nicht an die Zugschnittstelle übertragen wird, mehr als eine spezifizierte Anzahl von Malen an die Gegenseite übertragen wurden; wenn die Informationen, dass keine Sicherheitsbefehlsinformationen an die Zugschnittstelle übertragen wurden, mehr als die spezifizierte Anzahl von Malen an die Gegenseite übertragen wurden, stoppt es ein Übertragen, an die Gegenseite, von Informationen zum Übertragen von Sicherheitsbefehlsinformationen an die Zugschnittstelle, und die lokale Seite geht in einen Fehlerzustand über; wenn die Informationen zum Nichtübertragen von Sicherheitsbefehlsinformationen an die Zug-

schnittstelle länger als die spezifizierte Anzahl von Malen nicht an die Gegenseite übertragen wurden, überträgt es weiterhin, an die Gegenseite, Informationen zum Nichtübertragen von Sicherheitsbefehlsinformationen an die Zugschnittstelle;
T4: wenn die lokale Seite den Sicherheitsbefehl an die Zugschnittstelle überträgt, wird bestimmt, ob sich der Übertragungszustand des Sicherheitsbefehls ändert; wenn sich der Übertragungszustand des Sicherheitsbefehls ändert, wird bestimmt, ob der geänderte Übertragungszustand des Sicherheitsbefehls der lokalen Seite mit den empfangenen Sicherheitsbefehlsinformationen der Gegenseite konsistent ist; wenn der geänderte Übertragungszustand des Sicherheitsbefehls der lokalen Seite mit den empfangenen Sicherheitsbefehlsinformationen der Gegenseite übereinstimmt, behält die lokale Seite den geänderten Übertragungszustand des Sicherheitsbefehls bei und überträgt die geänderten Sicherheitsbefehlsinformationen an die Gegenseite, der zweite Zeitgeber wird beendet, es wird in einen Wartezustand auf eine Bestätigung von der Gegenseite übergegangen, es fährt mit der Ausführung von Schritt T5 fort; wenn der geänderte Übertragungszustand des Sicherheitsbefehls nicht mit den empfangenen Sicherheitsbefehlsinformationen der Gegenstelle übereinstimmt, wird der zweite Zeitgeber beendet, und die lokale Seite geht in einen Fehlerzustand über; ist die Antwort negativ, wird bestimmt, ob der zweite Zeitgeber abläuft; wenn der zweite Zeitgeber abläuft, wird der zweite Zeitgeber beendet, es geht in einen Fehlerzustand über; wenn der zweite Zeitgeber nicht abläuft, wird weiterhin bestimmt, ob sich der Übertragungszustand des Sicherheitsbefehls ändert, wenn die lokale Seite den Sicherheitsbefehl an die Zugschnittstelle überträgt;
T5: die geänderten Sicherheitsbefehlsinformationen werden periodisch an die Gegenseite übertragen, es wird bestimmt, ob Bestätigungsinformationen über den Sicherheitsbefehl der Gegenseite empfangen werden; wenn Bestätigungsinformationen über den Sicherheitsbefehl der Gegenseite empfangen werden, geht die lokale Seite in den Ruhezustand über; wenn keine Bestätigungsinformationen über den Sicherheitsbefehl der Gegenseite empfangen werden, wird bestimmt, ob die Anzahl von Übertragungen der geänderten Sicherheitsbefehlsinformationen an die Gegenseite eine spezifizierte Anzahl von Malen überschreitet; wenn die Anzahl der Übertragungen der geänderten Sicherheitsbefehlsinformationen an die Gegenseite die spezifizierte Anzahl überschreitet, geht die lokale Seite in einen Ruhezustand über; wenn die Anzahl von Übertragungen der geänderten Sicherheitsbefehlsinformationen an die Gegenseite die spezifizierte Anzahl nicht überschreitet, werden die geänderten Sicherheitsbefehlsinformationen weiterhin an die Gegenseite übertragen.

2. Verfahren zum Verarbeiten von Zugschnittstellendaten für die Hot-Standby-Bordausrüstung nach Anspruch 1, wobei ein Steuern der Eingangssignale, um konsistent zu sein, insbesondere die folgenden Schritte umfasst:

S 1: das zweite Hauptsteuergerät empfängt ein aktuell erfasstes erstes Eingangssignal, das von dem ersten Hauptsteuergerät übertragen wird;
S2: das zweite Hauptsteuergerät vergleicht das erste Eingangssignal mit einem aktuell erfassten zweiten Eingangssignal; wenn der Signalinhalt des ersten Eingangssignals und der Signalinhalt des zweiten Eingangssignals übereinstimmen, verwendet das erste Hauptsteuergerät das aktuell erfasste erste Eingangssignal als Eingang und das zweite Hauptsteuergerät das aktuell erfasste zweite Eingangssignal als Eingang; wenn der Signalinhalt des ersten Eingangssignals und der Signalinhalt des zweiten Eingangssignals nicht übereinstimmen, verwirft das erste Hauptsteuergerät das erste Eingangssignal und das zweite Hauptsteuergerät verwirft das zweite Eingangssignal, wobei das erste Hauptsteuergerät und das zweite Hauptsteuergerät weiterhin die vorherigen konsistenten Signale als Eingangssignale verwenden.

3. Verfahren zum Verarbeiten von Zugschnittstellendaten für die Hot-Standby-Bordausrüstung nach Anspruch 2, wobei, wenn der Signalinhalt des ersten Eingangssignals und der Signalinhalt des zweiten Eingangssignals nicht übereinstimmen, bestimmt wird, dass das zweite Hauptsteuergerät ausfällt, wenn eine Zeitspanne, für die der Signalinhalt des ersten Eingangssignals und der Signalinhalt des zweiten Eingangssignals nicht übereinstimmen, eine vorgeschriebene Zeitspanne überschreitet.

4. Verfahren zum Verarbeiten von Zugschnittstellendaten für die Hot-Standby-Bordausrüstung nach Anspruch 1, wobei ein Steuern der Eingangssignale, um konsistent zu sein, spezifisch wie folgt ist:

das erste Hauptsteuergerät empfängt ein

Stromeingangssignal und überträgt das Eingangssignal an das zweite Hauptsteuergerät; das zweite Hauptsteuergerät empfängt das Eingangssignal als sein eigenes Eingangssignal.

5. Verfahren zum Verarbeiten von Zugschnittstellendaten für die Hot-Standby-Bordausrüstung nach Anspruch 1, wobei der Sicherheitsbefehl einen Geschwindigkeitssteuerungsbefehl und einen Traktionsaufhebungsbefehl beinhaltet.

6. Verfahren zum Verarbeiten von Zugschnittstellendaten für die Hot-Standby-Bordausrüstung nach Anspruch 1, wobei das Verfahren ferner einen Bremstest der Bordausrüstung umfasst und der Bremstest die folgenden Schritte umfasst:

D1: nachdem das erste Hauptsteuergerät eine Bremstestanforderung empfangen hat, wird ein Bremstest ausgeführt; wenn der Bremstest fehlschlägt, wird der Fahrer daran erinnert, dass der Bremstest fehlschlägt, und der Bremstest wird erneut ausgeführt, bis der Bremstest erfolgreich ist; wenn der Bremstest erfolgreich ist, wird das zweite Hauptsteuergerät angewiesen, einen Bremstest auszuführen;
D2: nachdem das zweite Hauptsteuergerät den Befehl empfangen und eine Befehlsempfangsbestätigung an das erste Hauptsteuergerät übertragen hat, beginnt das zweite Hauptsteuergerät damit, einen Bremstest auszuführen; wenn der Bremstest erfolgreich ist, wird ein Bremstestergebnis an das erste Hauptsteuergerät übertragen, das erste Hauptsteuergerät meldet die Bremstestresultate der lokalen Seite und des zweiten Hauptsteuergeräts an den Fahrer zurück;
wenn der Bremstest fehlschlägt, wird bestimmt, ob die Anzahl von Bremsungen eine spezifizierte Anzahl von Bremsungen überschreitet, wenn dies der Fall ist, wird Schritt D3 ausgeführt, wenn dies nicht der Fall ist, wird Schritt D4 ausgeführt;
D3: der Bremstest wird so lange wiederholt, bis der Bremstest erfolgreich ist, danach wird das Resultat des Bremstests an das erste Hauptsteuergerät übertragen, das erste Hauptsteuergerät meldet die Resultate des Bremstests des lokalen Endgeräts und des zweiten Hauptsteuergeräts an den Fahrer zurück;
D4: das erste Hauptsteuergerät wird über das Testende informiert, das zweite Hauptsteuergerät geht in einen Fehlerzustand über; nachdem das erste Hauptsteuergerät eine Nachricht über das Testende des zweiten Hauptsteuergeräts erhalten hat, meldet es das Resultat des Bremstests des ersten Hauptsteuergeräts an den Fahrer zurück.

Revendications

1. Procédé permettant le traitement de données d'interface de train pour un équipement embarqué en réserve instantanée,

une seconde unité de commande principale étant utilisée pour effectuer une réserve instantanée d'une première unité de commande principale, une alimentation étant fournie simultanément à la première unité de commande principale et à la seconde unité de commande principale ;
ladite première unité de commande principale et ladite seconde unité de commande principale recevant des signaux d'entrée transmis par une interface de train, et commandant les signaux d'entrée pour qu'ils soient cohérents ;
lorsque l'équipement embarqué est en panne d'alimentation, ou lorsque la première unité de commande principale et la seconde unité de commande principale sont toutes les deux défaillantes, ledit équipement embarqué transmettant une instruction de sécurité à l'interface de train ;
lorsqu'au moins l'une de la première unité de commande principale et de la seconde unité de commande principale est dans un état de fonctionnement normal, ledit équipement embarqué déterminant si l'instruction de sécurité doit être transmise à l'interface de train selon une situation de fonctionnement ;
caractérisé en ce que
lorsque la première unité de commande principale et la seconde unité de commande principale fonctionnent toutes les deux normalement, la première unité de commande principale ou la seconde unité de commande principale détermine si l'instruction de sécurité doit être transmise à l'interface de train selon un état d'une extrémité locale et d'un état d'une extrémité homologue, comprenant :

T1 : initialement, à la fois l'extrémité locale et l'extrémité homologue dans un état inactif ;
T2 : lorsque l'extrémité locale transmet l'instruction de sécurité à l'interface de train, la détermination pour savoir si un état de transmission de l'instruction de sécurité change ; dans le cas où l'état d'émission de l'instruction de sécurité change, le lancement d'une première minuterie, l'entrée de l'extrémité homologue dans un état de surveillance, l'exécution de l'étape T3 ; dans le cas où l'état de transmission de l'instruction de sécurité ne change pas, la détermination pour savoir si des informations d'instruction

de sécurité de l'extrémité homologue sont reçues, si les informations d'instruction de sécurité de l'extrémité homologue sont reçues, la transmission d'un paquet d'accusé de réception des informations d'instruction de sécurité à l'extrémité homologue, et le lancement d'une seconde minuterie, l'entrée de l'extrémité locale dans un état de surveillance, l'exécution de l'étape T4 ; si aucune information d'instruction de sécurité de l'extrémité homologue n'est reçue, la poursuite de la détermination pour savoir si l'état de transmission de l'instruction de sécurité de l'extrémité locale change ;

T3 : la détermination pour savoir si l'état de transmission changé de l'instruction de sécurité doit transmettre l'instruction de sécurité à l'interface de train ; si l'état de transmission changé de l'instruction de sécurité transmet l'instruction de sécurité à l'interface de train, l'extrémité locale transmet l'instruction de sécurité à l'interface de train et transmet périodiquement, à l'extrémité homologue, des informations pour transmettre l'instruction de sécurité à l'interface de train, la poursuite de l'exécution de l'étape T3-1 ; si l'état de transmission changé de l'instruction de sécurité ne transmet pas l'instruction de sécurité à l'interface de train, la non transmission par l'extrémité locale de l'instruction de sécurité à l'interface de train et la transmission périodique par celle-ci, à l'extrémité homologue, des informations pour ne pas transmettre l'instruction de sécurité à l'interface de train, la poursuite de l'exécution de l'étape T3-2 ;

T3-1 : la détermination pour savoir si les informations d'instruction de sécurité de l'extrémité homologue sont reçues ; si les informations d'instruction de sécurité de l'extrémité homologue sont reçues, la transmission d'un paquet d'accusé de réception des informations d'instruction de sécurité à l'extrémité homologue, et la détermination pour savoir si les informations d'instruction de sécurité de l'extrémité homologue et l'état de transmission changé de l'instruction de sécurité de l'extrémité locale sont cohérents ; si les informations d'instruction de sécurité de l'extrémité homologue et l'état de transmission changé de l'instruction de sécurité de l'extrémité locale sont cohérents, l'arrêt de la première minuterie, l'entrée de l'extrémité locale dans un état inactif ; si les informations d'instruction de sécurité de l'extrémité homologue et l'état de transmission changé de l'instruction de sécurité de l'extrémité locale sont incohérents, l'entrée de l'extrémité locale dans un état de défaillance ; si aucune information d'instruction de sécurité de l'extrémité homologue n'est reçue, la détermination pour savoir si le minutage de la première minuterie expire ; si le minutage de la première minuterie expire, l'arrêt de la première minuterie, l'entrée de l'extrémité locale dans l'état inactif ; si le minutage de la première minuterie n'expire pas, la détermination pour savoir si un paquet d'accusé de réception des informations d'instruction de sécurité de l'extrémité homologue est reçu ; si le paquet d'accusé de réception des informations d'instruction de sécurité de l'extrémité homologue est reçu, l'arrêt de la transmission, à l'extrémité homologue, des informations pour la transmission des informations d'instruction de sécurité à l'interface de train, le maintien d'un état actuel ; si aucun paquet d'accusé de réception des informations d'instruction de sécurité de l'extrémité homologue n'est reçu, la détermination pour savoir si les informations pour la transmission des informations d'instruction de sécurité à l'interface de train ont été transmises à l'extrémité homologue plus d'un nombre spécifié de fois ; si les informations pour la transmission des informations d'instruction de sécurité à l'interface de train ont été transmises à l'extrémité homologue plus que le nombres spécifié de fois, l'arrêt de la transmission, à l'extrémité homologue, des informations pour la transmission des informations d'instruction de sécurité à l'interface de train, et l'entrée de l'extrémité locale dans un état de défaillance ; si les informations pour la transmission des informations d'instruction de sécurité à l'interface de train n'ont pas été transmises à l'extrémité homologue plus que le nombre de fois spécifié, la poursuite de la transmission, à l'extrémité homologue, des informations pour la transmission des informations d'instruction de sécurité à l'interface de train ;

T3-2 : la détermination pour savoir si les informations d'instruction de sécurité de l'extrémité homologue sont reçues ; si les informations d'instruction de sécurité de l'extrémité homologue sont reçues, la transmission d'un paquet d'accusé de réception des informations d'instruction de sécurité à l'extrémité homologue, et la détermination pour savoir si les informations d'instruction de sécurité de l'extrémité homologue et l'état de transmission changé de l'instruction de sécurité de l'extrémité locale sont cohérents ; si les informations d'instruction

de sécurité de l'extrémité homologue et l'état de transmission changé de l'instruction de sécurité de l'extrémité locale sont cohérents, l'arrêt de la première minuterie, l'entrée de l'extrémité locale dans un état inactif ; si les informations d'instruction de sécurité de l'extrémité homologue et l'état de transmission changé de l'instruction de sécurité de l'extrémité locale sont incohérents, l'entrée de l'extrémité locale dans un état de défaillance ; si aucune information d'instruction de sécurité de l'extrémité homologue n'est reçue, la détermination pour savoir si le minutage de la première minuterie expire ; si le minutage de la première minuterie expire, l'arrêt de la première minuterie, l'entrée de l'extrémité locale dans l'état inactif ; si le minutage de la première minuterie n'expire pas, la détermination pour savoir si un paquet d'accusé de réception des informations d'instruction de sécurité de l'extrémité homologue est reçu ; si le paquet d'accusé de réception des informations d'instruction de sécurité de l'extrémité homologue est reçu, l'arrêt de la transmission, à l'extrémité homologue, des informations pour la non transmission des informations d'instruction de sécurité à l'interface de train, le maintien d'un état actuel ; si aucun paquet d'accusé de réception pour des informations d'instruction de sécurité de l'extrémité homologue n'est reçu, la détermination pour savoir si les informations pour la non transmission d'informations d'instruction de sécurité à l'interface de train ont été transmises à l'extrémité homologue plus d'un nombre spécifié de fois ; si les informations pour la non-transmission d'informations d'instruction de sécurité à l'interface de train ont été transmises à l'extrémité homologue plus que le nombre spécifié de fois, l'arrêt de la transmission, à l'extrémité homologue, des informations pour la transmission d'informations d'instruction de sécurité à l'interface de train, et l'entrée de l'extrémité locale dans un état de défaillance ; si les informations pour la non-transmission d'informations d'instruction de sécurité à l'interface de train n'ont pas été transmises à l'extrémité homologue plus que le nombre spécifié de fois, la poursuite de la transmission, à l'extrémité homologue, des informations pour la non-transmission d'informations d'instruction de sécurité à l'interface de train ;

T4 : lorsque l'extrémité locale transmet l'instruction de sécurité à l'interface de train, la détermination pour savoir si l'état de transmission de l'instruction de sécurité change ; dans le cas où l'état de transmission de l'instruction de sécurité change, la détermination pour savoir si l'état de transmission changé de l'instruction de sécurité de l'extrémité locale est cohérent avec les informations d'instruction de sécurité de l'extrémité homologue telles qu'elles ont été reçues ; si l'état de transmission changé de l'instruction de sécurité de l'extrémité locale est cohérent avec les informations d'instruction de sécurité de l'extrémité homologue telles qu'elles ont été reçues, le maintien par l'extrémité locale de l'état de transmission changé de l'instruction de sécurité et la transmission par celle-ci des informations d'instruction de sécurité changées à l'extrémité homologue, l'arrêt de la seconde minuterie, elle entre dans un état d'attente de l'accusé de réception en provenance de l'extrémité homologue, la poursuite de l'exécution de l'étape T5 ; si l'état de transmission changé de l'instruction de sécurité est incohérent avec les informations d'instruction de sécurité de l'homologue telles qu'elles ont été reçues, l'arrêt de la seconde minuterie, l'entrée de l'extrémité locale dans un état de défaillance ; si la réponse est négative, la détermination pour savoir si la seconde minuterie expire ; si la seconde minuterie expire, l'arrêt de la seconde minuterie, son entrée dans un état de défaillance ; si la seconde minuterie n'expire pas, la poursuite de la détermination pour savoir si l'état de transmission de l'instruction de sécurité change lorsque l'extrémité locale transmet l'instruction de sécurité à l'interface de train ;

T5 : la transmission périodique des informations d'instruction de sécurité changées à l'extrémité homologue, la détermination pour savoir si des informations d'accusé de réception concernant l'instruction de sécurité de l'extrémité homologue sont reçues ; si des informations d'accusé de réception concernant l'instruction de sécurité de l'extrémité homologue sont reçues, l'entrée de l'extrémité locale dans un état inactif ; si aucune information d'accusé de réception concernant l'instruction de sécurité de l'extrémité homologue n'est reçue, la détermination pour savoir si le nombre de fois que les informations d'instruction de sécurité changées ont été transmises à l'extrémité homologue dépasse un nombre spécifié de fois ; si le nombre de fois que les informations d'instruction de sécurité changées ont été transmises à l'extrémité homologue dé-

passe le nombre spécifié de fois, l'entrée de l'extrémité locale dans un état inactif ; si le nombre de fois que les informations d'instruction de sécurité changées ont été transmises à l'extrémité homologue ne dépasse pas le nombre spécifié de fois, la poursuite de la transmission des informations d'instruction de sécurité changées à l'extrémité homologue.

2. Procédé permettant le traitement de données d'interface de train pour l'équipement embarqué en réserve instantanée de la revendication 1, ladite commande des signaux d'entrée pour qu'ils soient cohérents comprenant spécifiquement les étapes suivantes :

S1 : la seconde unité de commande principale reçoit un premier signal d'entrée actuellement collecté transmis par la première unité de commande principale ;
S2 : la seconde unité de commande principale compare le premier signal d'entrée avec un second signal d'entrée actuellement collecté ; si le contenu de signal du premier signal d'entrée et le contenu de signal du second signal d'entrée sont cohérents, la première unité de commande principale utilise le premier signal d'entrée actuellement collecté en tant qu'entrée et la seconde unité de commande principale utilise le second signal d'entrée actuellement collecté en tant qu'entrée ; si le contenu de signal du premier signal d'entrée et le contenu de signal du second signal d'entrée sont incohérents, la première unité de commande principale rejette le premier signal d'entrée et la seconde unité de commande principale rejette le second signal d'entrée, la première unité de commande principale et la seconde unité de commande principale continuent d'utiliser les signaux cohérents précédents en tant qu'entrée.

3. Procédé permettant le traitement de données d'interface de train pour l'équipement embarqué en réserve instantanée de la revendication 2, lorsque le contenu de signal du premier signal d'entrée et le contenu de signal du second signal d'entrée sont incohérents, la détermination que la seconde unité de commande principale tombe est défaillante si une période de temps pendant laquelle le contenu de signal du premier signal d'entrée et le contenu de signal du second signal d'entrée sont incohérents dépasse une période de temps prévue.

4. Procédé permettant le traitement de données d'interface de train pour l'équipement embarqué en réserve instantanée de la revendication 1, ladite commande des signaux d'entrée pour qu'ils soient cohérents étant spécifiquement :

la première unité de commande principale reçoit un signal d'entrée actuel et transmet le signal d'entrée à la seconde unité de commande principale ;
la seconde unité de commande principale reçoit le signal d'entrée comme son propre signal d'entrée.

5. Procédé permettant le traitement de données d'interface de train pour l'équipement embarqué en réserve instantanée de la revendication 1, ladite instruction de sécurité comprenant une instruction de commande de vitesse et une instruction de suppression de traction.

6. Procédé permettant le traitement de données d'interface de train pour l'équipement embarqué en réserve instantanée de la revendication 1, ledit procédé comprenant en outre un essai de freinage de l'équipement embarqué, et l'essai de freinage comprend les étapes suivantes :

D1 : après que la première unité de commande principale a reçu une demande d'essai de freinage, un essai de freinage est réalisé ; si l'essai de freinage échoue, un rappel est fait au conducteur indiquant que l'essai de freinage a échoué, l'essai de freinage étant exécuté de nouveau jusqu'à ce que l'essai de freinage soit réussi ; si l'essai de freinage est réussi, la seconde unité de commande principale reçoit l'instruction de réaliser un essai de freinage ;
D2 : après que la seconde unité de commande principale a reçu l'instruction et transmis un accusé de réception d'instruction à la première unité de commande principale, la seconde unité de commande principale commence à réaliser un essai de freinage ; si l'essai de freinage est réussi, un résultat d'essai de freinage est transmis à la première unité de commande principale, la première unité de commande principale renvoie les résultats d'essai de freinage de l'extrémité locale et de la seconde unité de commande principale au conducteur ;
si l'essai de freinage échoue, la détermination pour savoir si le nombre de freinages dépasse un nombre spécifié, l'exécution de l'étape D3 dans le cas où il le dépasse, l'exécution de l'étape D4 dans le cas où il ne le dépasse pas ;
D3 : l'essai de freinage est répété jusqu'à ce que l'essai de freinage soit réussi, après quoi le résultat d'essai de freinage est transmis à la première unité de commande principale, la première unité de commande principale renvoie les résultats d'essai de freinage de l'extrémité locale et de la seconde unité de commande principale

au conducteur ;
D4 : la première unité de commande principale étant informée de la fin de l'essai, la seconde unité de commande principale entre dans un état de défaillance ; après que la première unité de commande principale a reçu un message de fin d'essai de la seconde unité de commande principale, elle renvoie le résultat d'essai de freinage de la première unité de commande principale au conducteur.

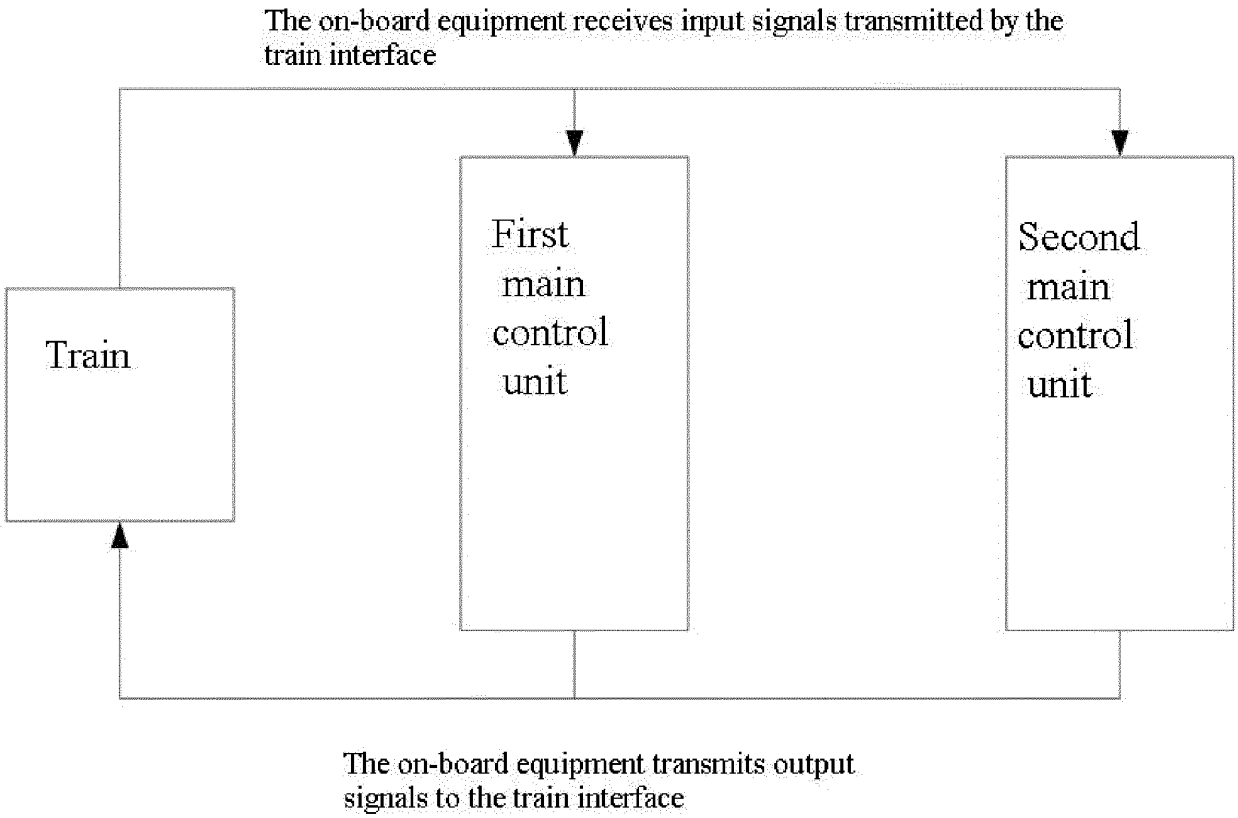
The on-board equipment receives input signals transmitted by the train interface
Train
First main control unit
Second main control unit
The on-board equipment transmits output signals to the train interface

Fig 1

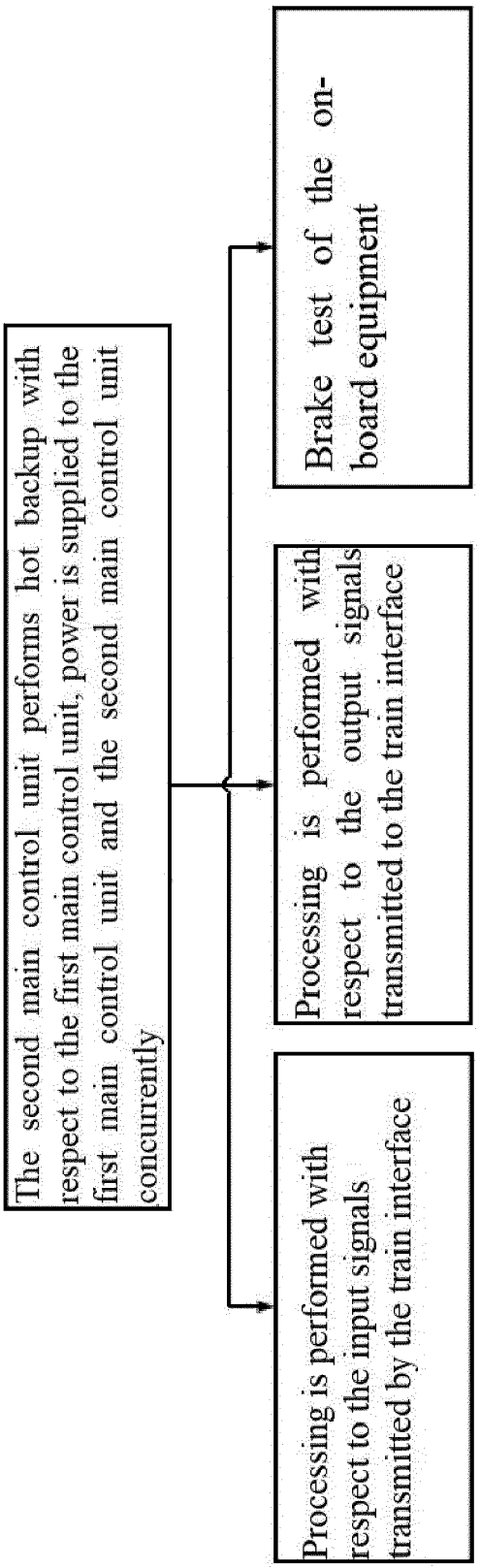
The second main control unit performs hot backup with respect to the first main control unit, power is supplied to the first main control unit and the second main control unit concurrently
Processing is performed with respect to the input signals transmitted by the train interface
Processing is performed with respect to the output signals transmitted to the train interface
Brake test of the on-board equipment

Fig 2

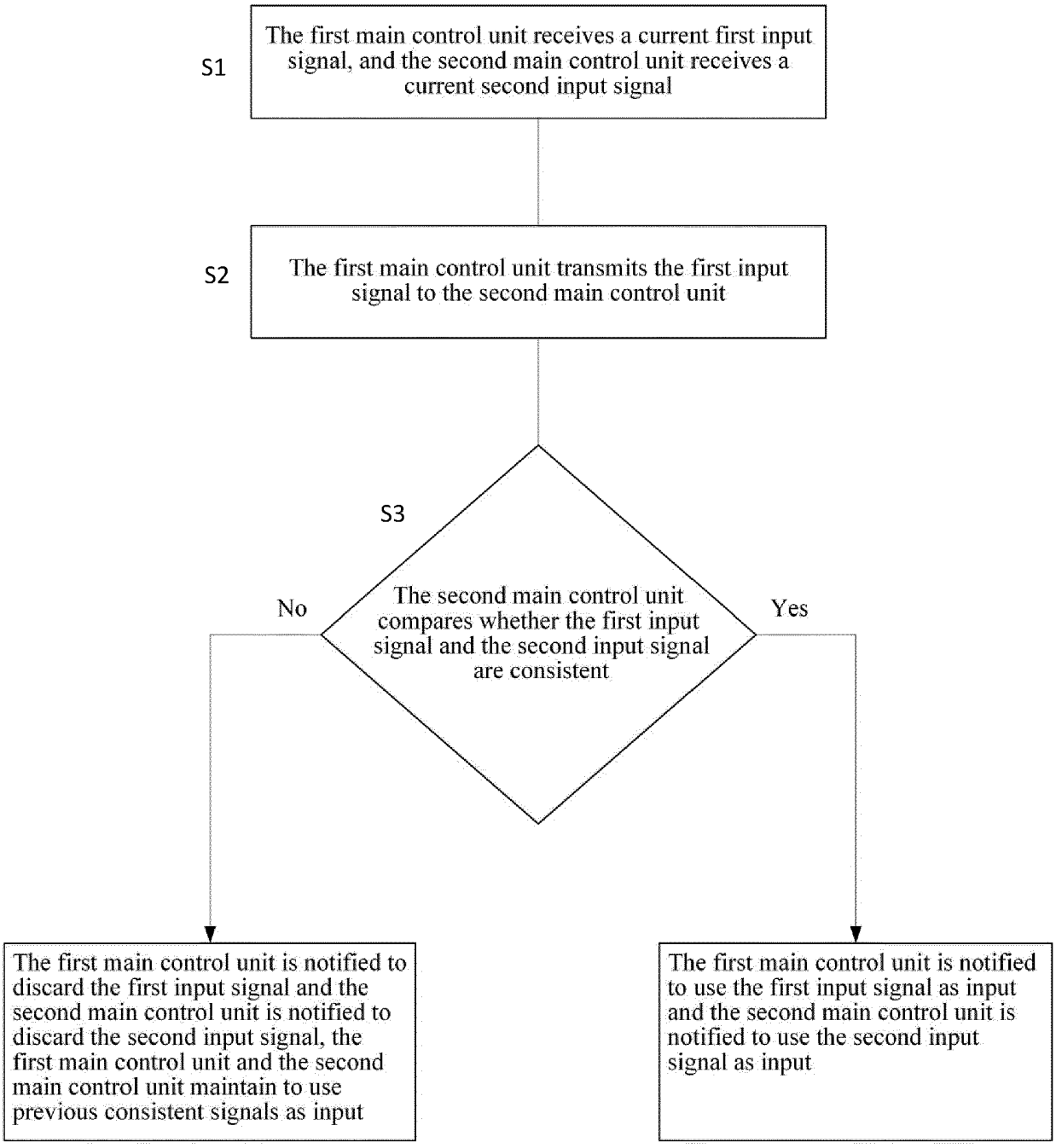
S1
The first main control unit receives a current first input signal, and the second main control unit receives a current second input signal
S2
The first main control unit transmits the first input signal to the second main control unit
S3
The second main control unit compares whether the first input signal and the second input signal are consistent
No
Yes
The first main control unit is notified to discard the first input signal and the second main control unit is notified to discard the second input signal, the first main control unit and the second main control unit maintain to use previous consistent signals as input
The first main control unit is notified to use the first input signal as input and the second main control unit is notified to use the second input signal as input

Fig 3

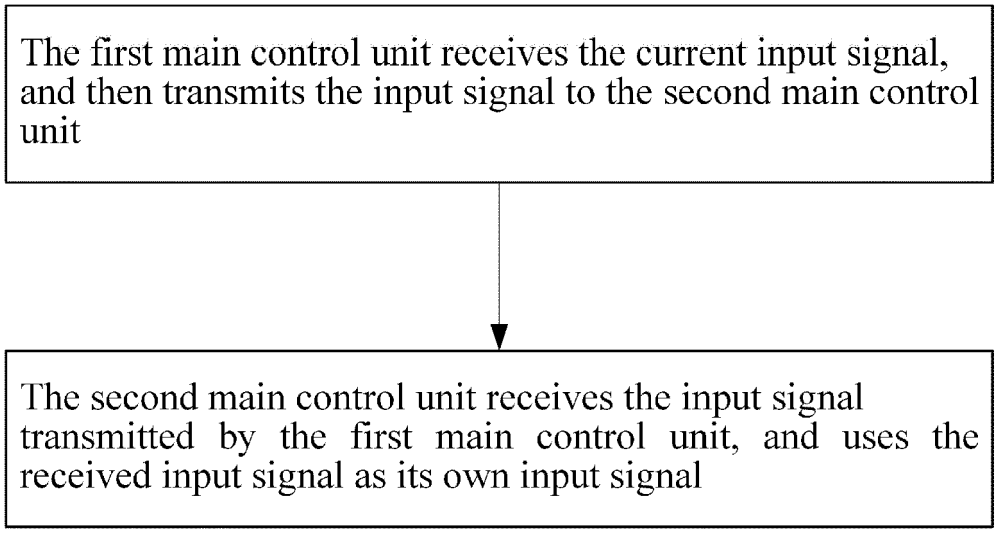
The first main control unit receives the current input signal, and then transmits the input signal to the second main control unit
The second main control unit receives the input signal transmitted by the first main control unit, and uses the received input signal as its own input signal

Fig 4

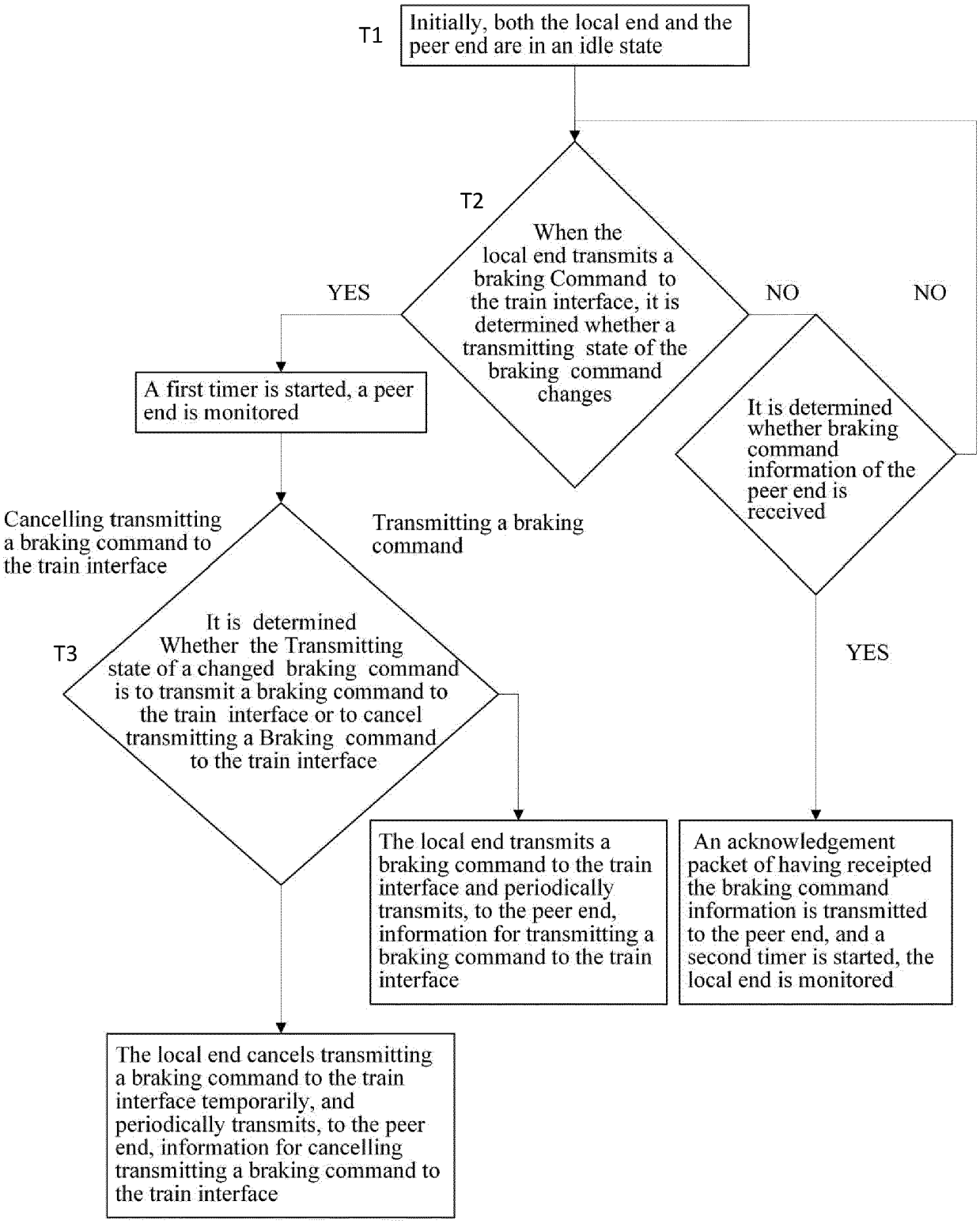
T1
Initially, both the local end and the peer end are in an idle state
T2
When the local end transmits a braking Command to the train interface, it is determined whether a transmitting state of the braking command changes
YES
NO
NO
A first timer is started, a peer end is monitored
It is determined whether braking command information of the peer end is received
Cancelling transmitting a braking command to the train interface
Transmitting a braking command
T3
It is determined Whether the Transmitting state of a changed braking command is to transmit a braking command to the train interface or to cancel transmitting a Braking command to the train interface
YES
The local end transmits a braking command to the train interface and periodically transmits, to the peer end, information for transmitting a braking command to the train interface
An acknowledgement packet of having receipted the braking command information is transmitted to the peer end, and a second timer is started, the local end is monitored
The local end cancels transmitting a braking command to the train interface temporarily, and periodically transmits, to the peer end, information for cancelling transmitting a braking command to the train interface

Fig 5

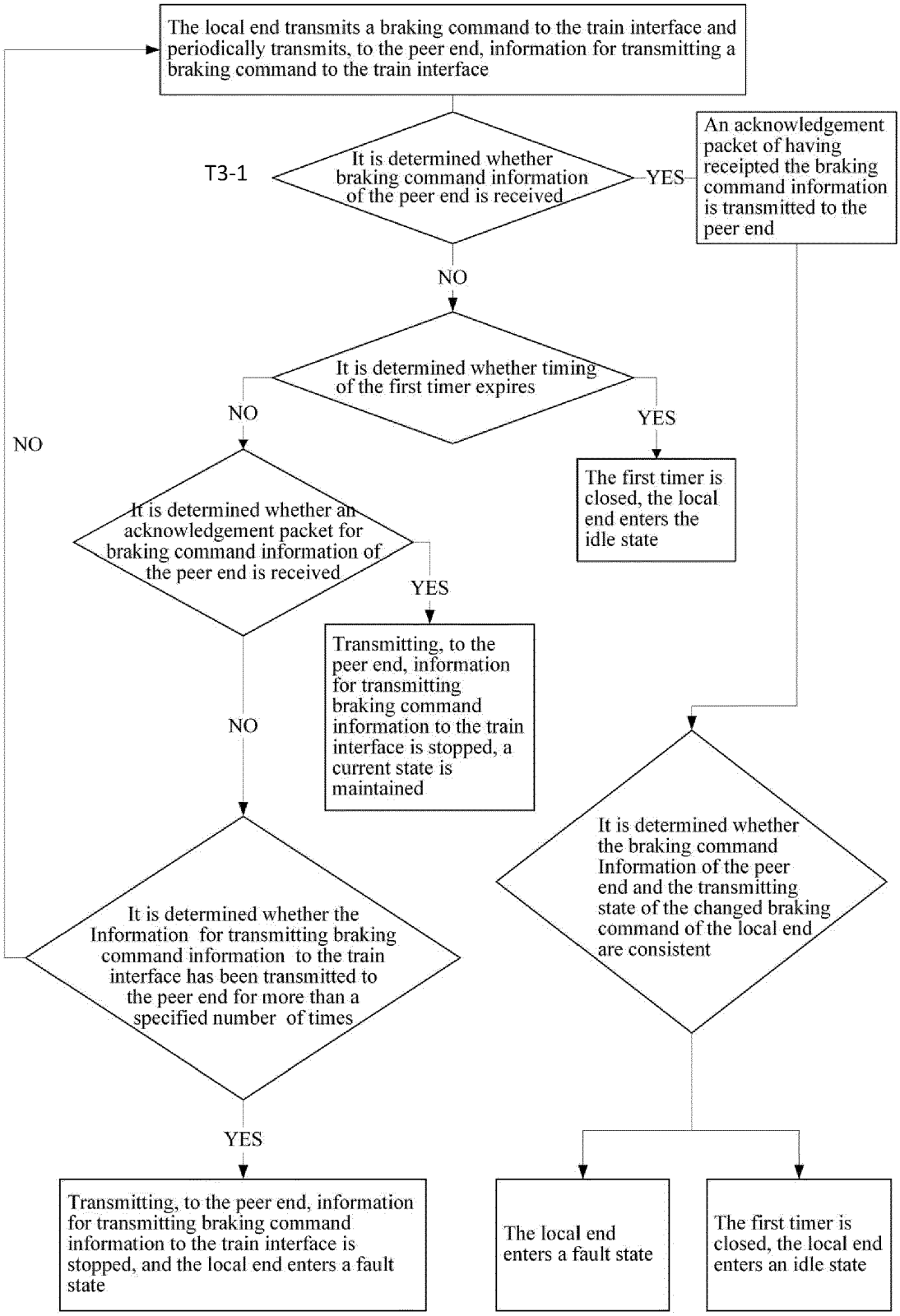
The local end transmits a braking command to the train interface and periodically transmits, to the peer end, information for transmitting a braking command to the train interface
T3-1
It is determined whether braking command information of the peer end is received
YES
An acknowledgement packet of having receipted the braking command information is transmitted to the peer end
NO
It is determined whether timing of the first timer expires
NO
YES
NO
The first timer is closed, the local end enters the idle state
It is determined whether an acknowledgement packet for braking command information of the peer end is received
YES
Transmitting, to the peer end, information for transmitting braking command information to the train interface is stopped, a current state is maintained
NO
It is determined whether the braking command Information of the peer end and the transmitting state of the changed braking command of the local end are consistent
It is determined whether the Information for transmitting braking command information to the train interface has been transmitted to the peer end for more than a specified number of times
YES
Transmitting, to the peer end, information for transmitting braking command information to the train interface is stopped, and the local end enters a fault state
The local end enters a fault state
The first timer is closed, the local end enters an idle state

Fig 6

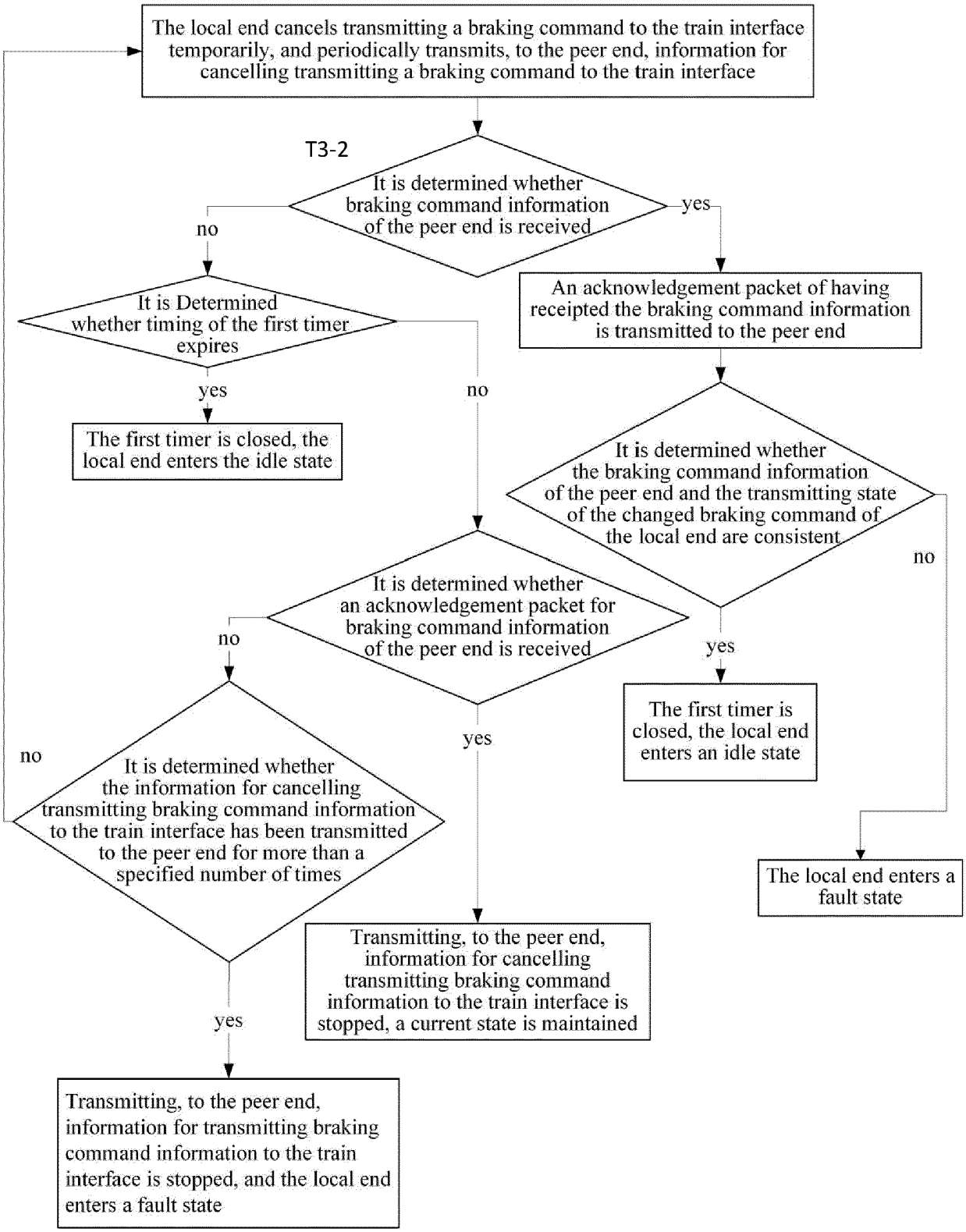
The local end cancels transmitting a braking command to the train interface temporarily, and periodically transmits, to the peer end, information for cancelling transmitting a braking command to the train interface
T3-2
It is determined whether braking command information of the peer end is received
yes
no
An acknowledgement packet of having receipted the braking command information is transmitted to the peer end
It is Determined whether timing of the first timer expires
yes
no
The first timer is closed, the local end enters the idle state
It is determined whether the braking command information of the peer end and the transmitting state of the changed braking command of the local end are consistent
no
yes
The local end enters a fault state
It is determined whether an acknowledgement packet for braking command information of the peer end is received
no
yes
The first timer is closed, the local end enters an idle state
no
It is determined whether the information for cancelling transmitting braking command information to the train interface has been transmitted to the peer end for more than a specified number of times
yes
Transmitting, to the peer end, information for cancelling transmitting braking command information to the train interface is stopped, a current state is maintained
Transmitting, to the peer end, information for transmitting braking command information to the train interface is stopped, and the local end enters a fault state

Fig 7

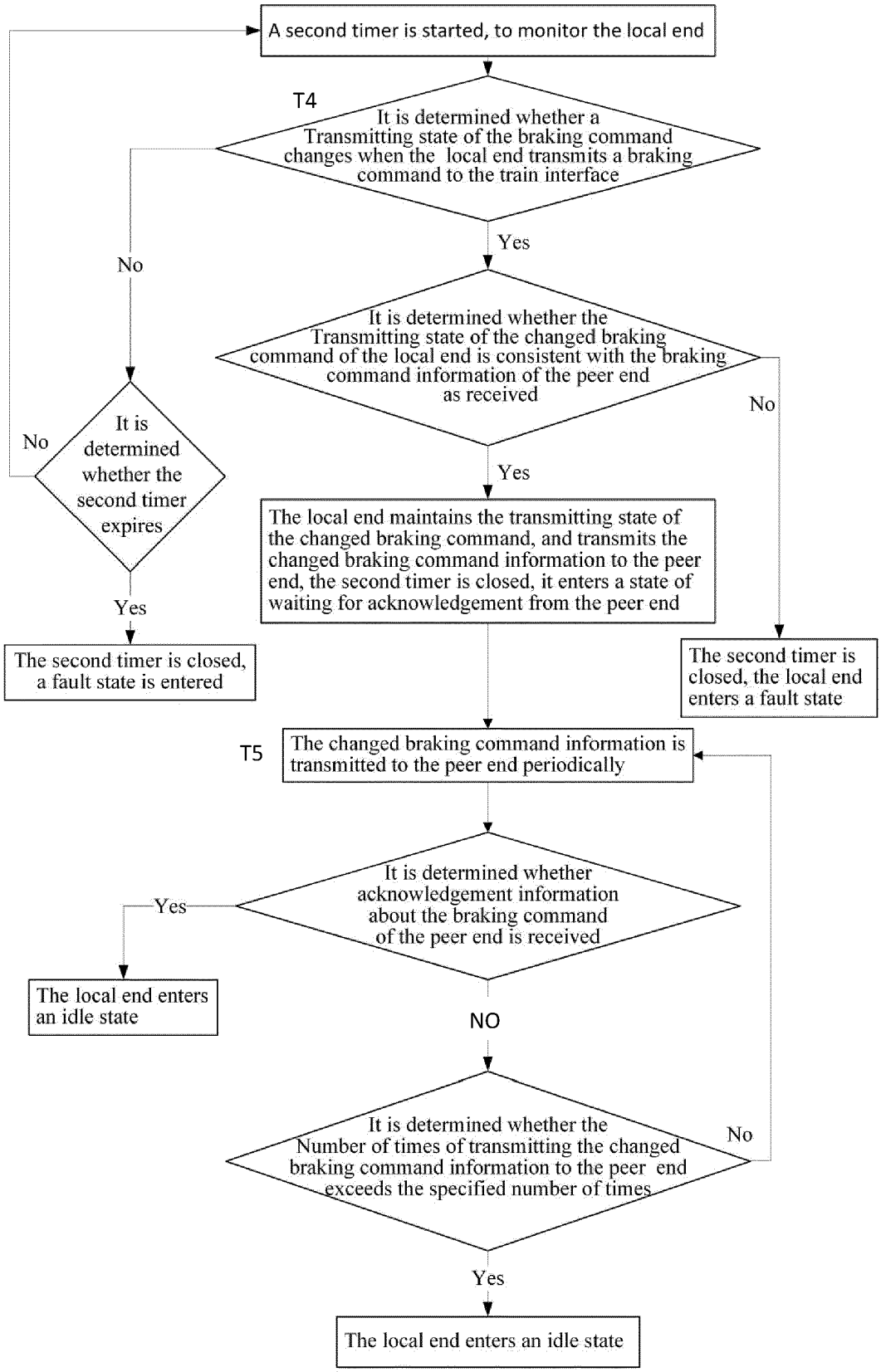
A second timer is started, to monitor the local end
T4
It is determined whether a Transmitting state of the braking command changes when the local end transmits a braking command to the train interface
Yes
No
It is determined whether the Transmitting state of the changed braking command of the local end is consistent with the braking command information of the peer end as received
No
Yes
It is determined whether the second timer expires
No
Yes
The local end maintains the transmitting state of the changed braking command, and transmits the changed braking command information to the peer end, the second timer is closed, it enters a state of waiting for acknowledgement from the peer end
The second timer is closed, a fault state is entered
The second timer is closed, the local end enters a fault state
T5
The changed braking command information is transmitted to the peer end periodically
It is determined whether acknowledgement information about the braking command of the peer end is received
Yes
The local end enters an idle state
NO
It is determined whether the Number of times of transmitting the changed braking command information to the peer end exceeds the specified number of times
No
Yes
The local end enters an idle state

Fig 8

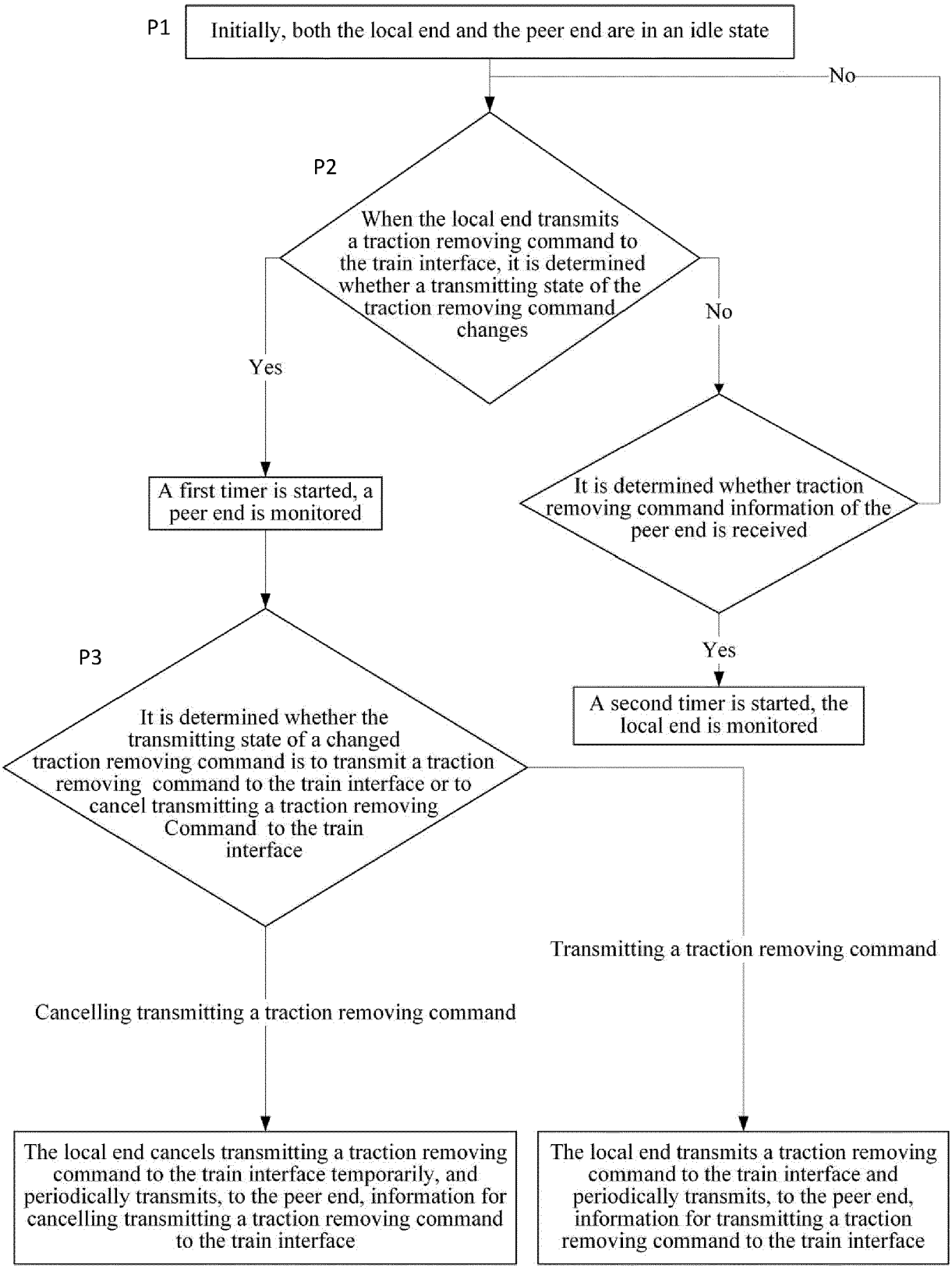
P1
Initially, both the local end and the peer end are in an idle state
No
P2
When the local end transmits a traction removing command to the train interface, it is determined whether a transmitting state of the traction removing command changes
No
Yes
A first timer is started, a peer end is monitored
It is determined whether traction removing command information of the peer end is received
Yes
A second timer is started, the local end is monitored
P3
It is determined whether the transmitting state of a changed traction removing command is to transmit a traction removing command to the train interface or to cancel transmitting a traction removing Command to the train interface
Transmitting a traction removing command
Cancelling transmitting a traction removing command
The local end cancels transmitting a traction removing command to the train interface temporarily, and periodically transmits, to the peer end, information for cancelling transmitting a traction removing command to the train interface
The local end transmits a traction removing command to the train interface and periodically transmits, to the peer end, information for transmitting a traction removing command to the train interface

Fig 9

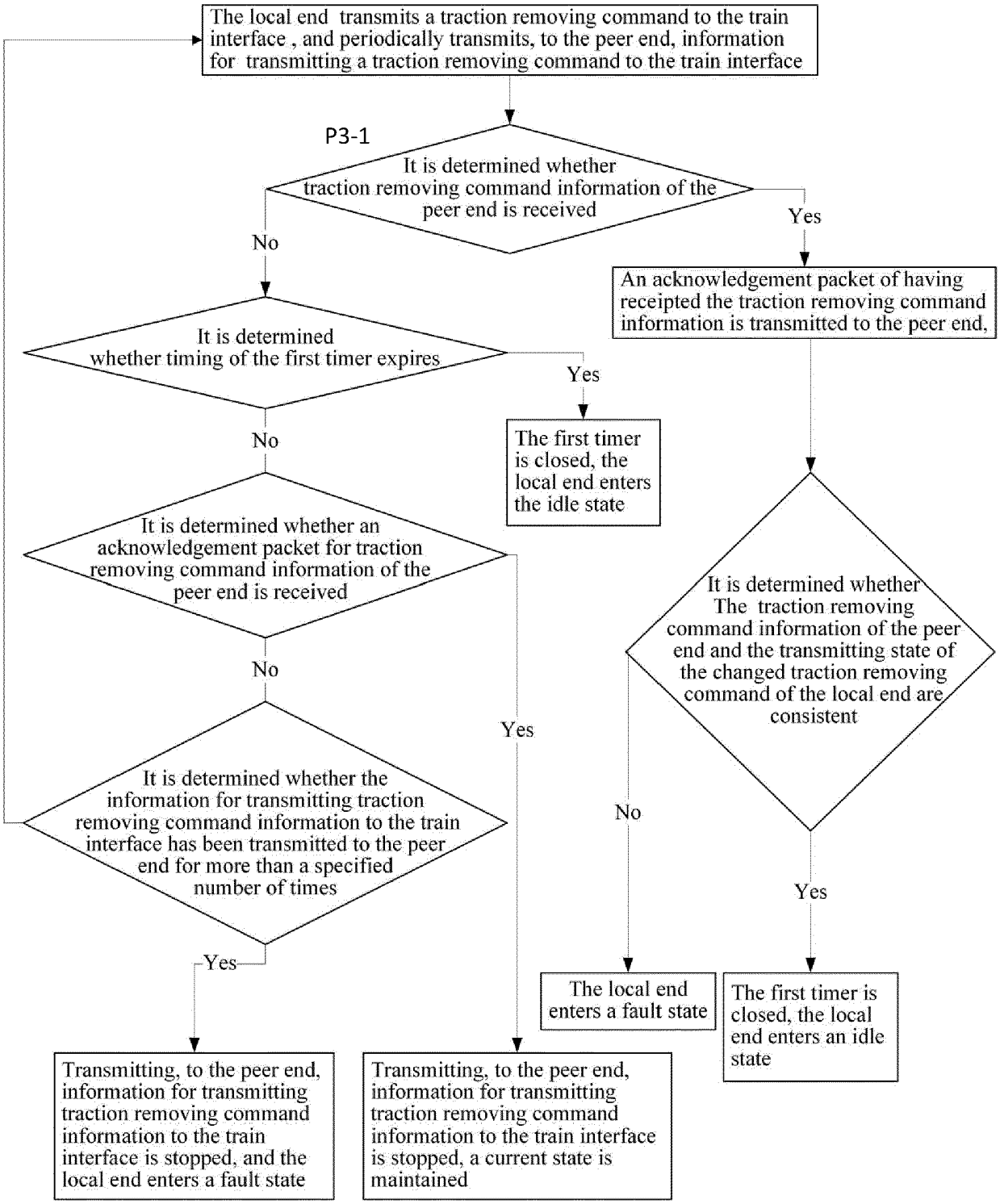
The local end transmits a traction removing command to the train interface , and periodically transmits, to the peer end, information for transmitting a traction removing command to the train interface
P3-1
It is determined whether traction removing command information of the peer end is received
Yes
No
An acknowledgement packet of having receipted the traction removing command information is transmitted to the peer end,
It is determined whether timing of the first timer expires
Yes
No
The first timer is closed, the local end enters the idle state
It is determined whether an acknowledgement packet for traction removing command information of the peer end is received
No
Yes
It is determined whether The traction removing command information of the peer end and the transmitting state of the changed traction removing command of the local end are consistent
It is determined whether the information for transmitting traction removing command information to the train interface has been transmitted to the peer end for more than a specified number of times
No
Yes
Yes
The local end enters a fault state
The first timer is closed, the local end enters an idle state
Transmitting, to the peer end, information for transmitting traction removing command information to the train interface is stopped, and the local end enters a fault state
Transmitting, to the peer end, information for transmitting traction removing command information to the train interface is stopped, a current state is maintained

Fig 10

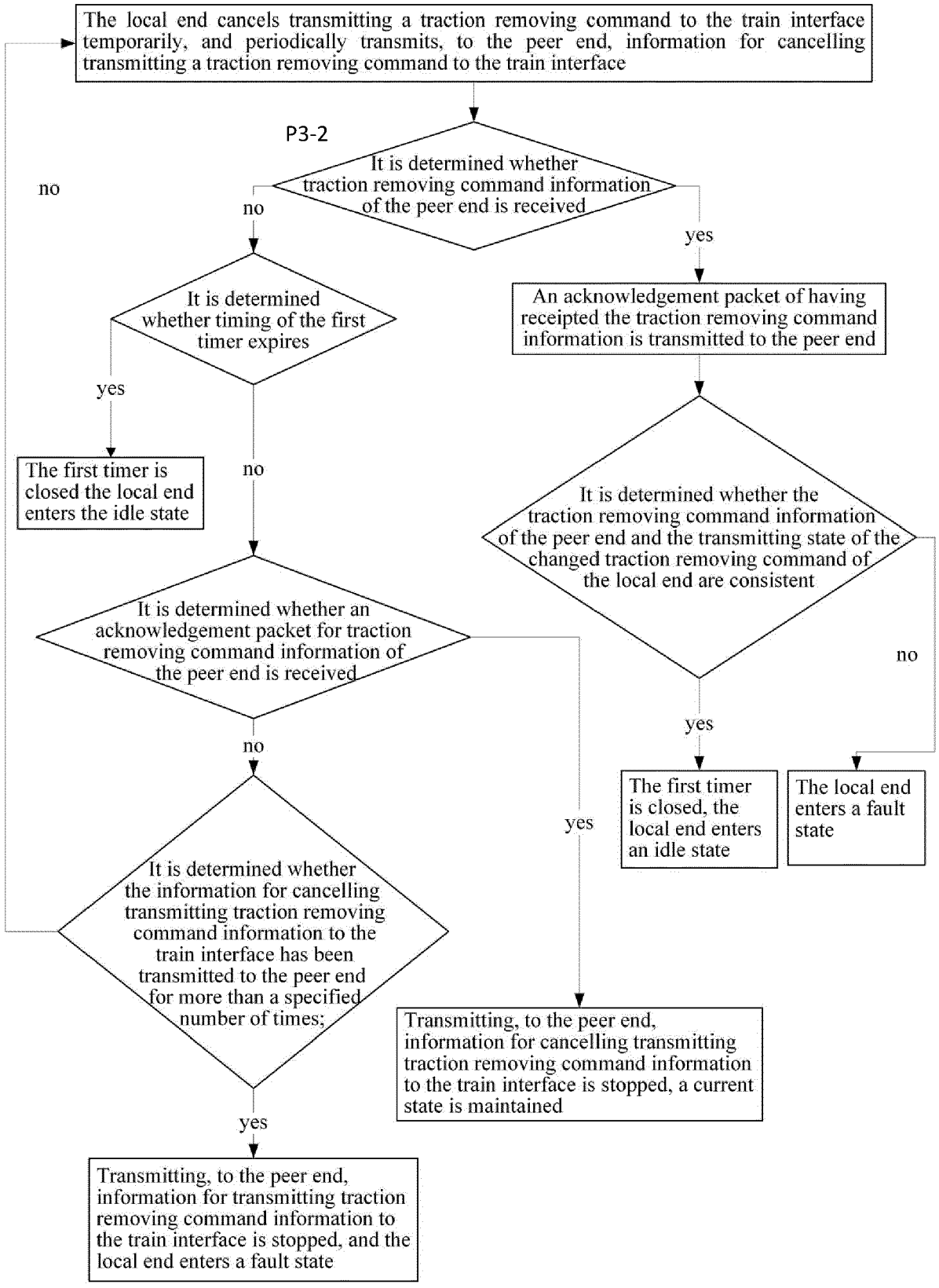
The local end cancels transmitting a traction removing command to the train interface temporarily, and periodically transmits, to the peer end, information for cancelling transmitting a traction removing command to the train interface
P3-2
It is determined whether traction removing command information of the peer end is received
no
yes
no
It is determined whether timing of the first timer expires
yes
The first timer is closed the local end enters the idle state
no
It is determined whether an acknowledgement packet for traction removing command information of the peer end is received
no
yes
It is determined whether the information for cancelling transmitting traction removing command information to the train interface has been transmitted to the peer end for more than a specified number of times;
yes
Transmitting, to the peer end, information for transmitting traction removing command information to the train interface is stopped, and the local end enters a fault state
An acknowledgement packet of having receipted the traction removing command information is transmitted to the peer end
It is determined whether the traction removing command information of the peer end and the transmitting state of the changed traction removing command of the local end are consistent
yes
The first timer is closed, the local end enters an idle state
no
The local end enters a fault state
yes
Transmitting, to the peer end, information for cancelling transmitting traction removing command information to the train interface is stopped, a current state is maintained

Fig 11

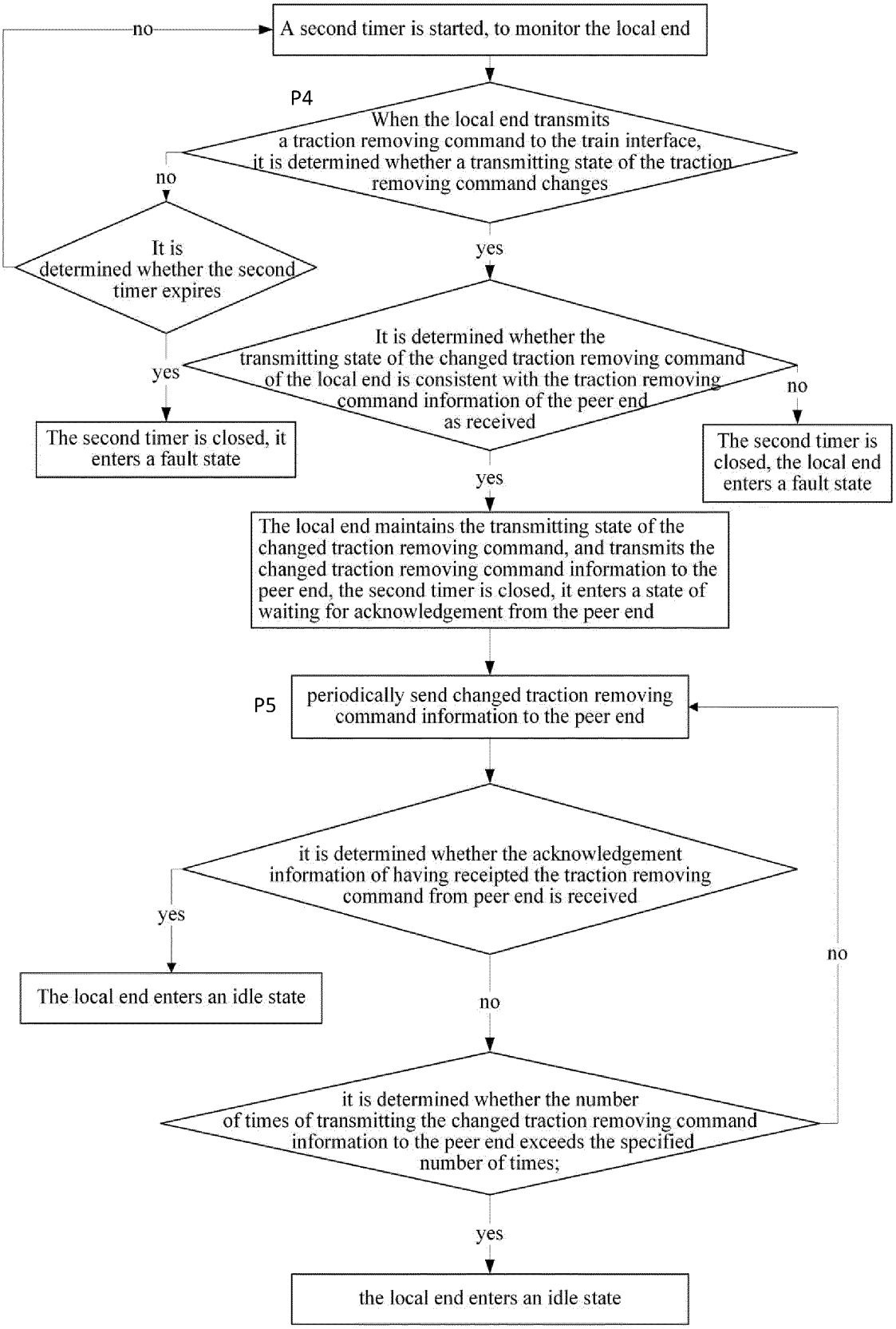
A second timer is started, to monitor the local end
P4
When the local end transmits a traction removing command to the train interface, it is determined whether a transmitting state of the traction removing command changes
no
yes
It is determined whether the second timer expires
yes
The second timer is closed, it enters a fault state
It is determined whether the transmitting state of the changed traction removing command of the local end is consistent with the traction removing command information of the peer end as received
no
The second timer is closed, the local end enters a fault state
yes
The local end maintains the transmitting state of the changed traction removing command, and transmits the changed traction removing command information to the peer end, the second timer is closed, it enters a state of waiting for acknowledgement from the peer end
P5
periodically send changed traction removing command information to the peer end
it is determined whether the acknowledgement information of having receipted the traction removing command from peer end is received
yes
The local end enters an idle state
no
no
it is determined whether the number of times of transmitting the changed traction removing command information to the peer end exceeds the specified number of times;
yes
the local end enters an idle state

Fig 12

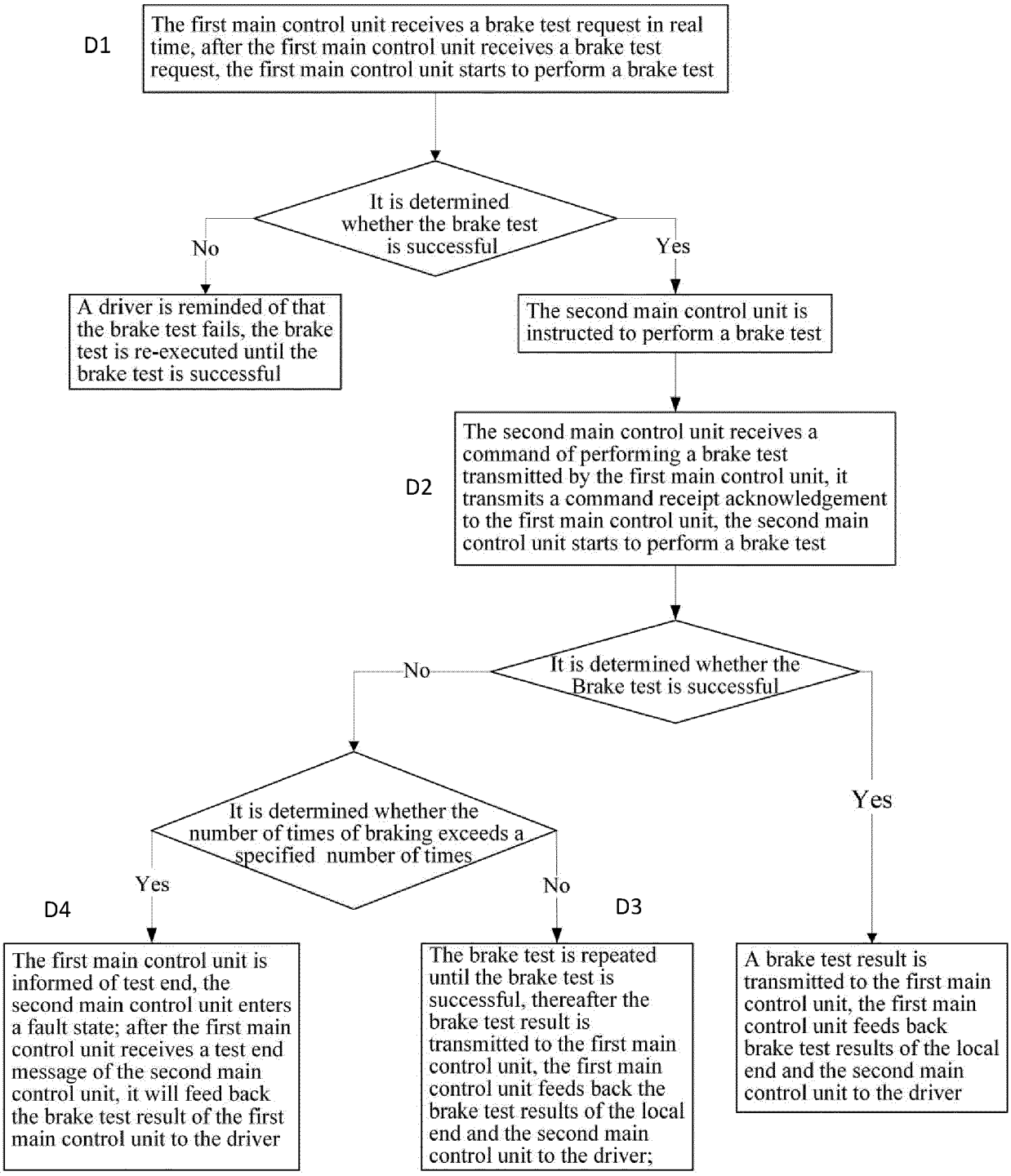
D1
The first main control unit receives a brake test request in real time, after the first main control unit receives a brake test request, the first main control unit starts to perform a brake test
It is determined whether the brake test is successful
No
Yes
A driver is reminded of that the brake test fails, the brake test is re-executed until the brake test is successful
The second main control unit is instructed to perform a brake test
D2
The second main control unit receives a command of performing a brake test transmitted by the first main control unit, it transmits a command receipt acknowledgement to the first main control unit, the second main control unit starts to perform a brake test
It is determined whether the Brake test is successful
No
Yes
It is determined whether the number of times of braking exceeds a specified number of times
Yes
No
D4
D3
The first main control unit is informed of test end, the second main control unit enters a fault state; after the first main control unit receives a test end message of the second main control unit, it will feed back the brake test result of the first main control unit to the driver
The brake test is repeated until the brake test is successful, thereafter the brake test result is transmitted to the first main control unit, the first main control unit feeds back the brake test results of the local end and the second main control unit to the driver;
A brake test result is transmitted to the first main control unit, the first main control unit feeds back brake test results of the local end and the second main control unit to the driver

Fig 13

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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- CN 109946956 A **[0003]**