CLAIMS

1. A method for controlling a medium voltage alternating current bus, applied to an auxiliary power supply system of a high-speed multiple-unit train, the high-speed multiple-unit train comprising at least one carriage group each comprising eight carriages, the auxiliary power supply system comprising a plurality of traction auxiliary converters arranged in different carriages and a plurality of circuit breakers connected between the plurality of traction auxiliary converters, the plurality of traction auxiliary converters forming an entire medium voltage alternating current bus, the plurality of circuit breakers dividing the entire medium voltage alternating current bus into a plurality of medium voltage alternating current sub-buses, and the method for controlling a medium voltage alternating current bus comprising:

S101: determining whether the bus has a short-circuit fault, controlling all the circuit breakers to be closed and controlling all the traction auxiliary converters to operate if the bus has no short-circuit fault, and proceeding to step S102 if the bus has a short-circuit fault;

S102: determining whether any one of the traction auxiliary converters has an internal short-circuit fault, proceeding to step S103 if one of the traction auxiliary converters has the internal short-circuit fault, and proceeding to step S104 if no one of the traction auxiliary converters has the internal short-circuit fault;

S103: controlling the traction auxiliary converter that has the internal short-circuit fault to stop operating;

S104: opening all the circuit breakers, performing a short-circuit test on each of the medium voltage alternating current sub-buses, and acquiring information on a traction auxiliary converter that reports a bus short-circuit fault;

S105: determining a medium voltage alternating current sub-bus that has a fault based on the information on the traction auxiliary converter that reports the bus short-circuit fault;

S106: controlling operation states of the circuit breakers and operation states of the traction auxiliary converters based on the determined medium voltage alternating current sub-bus that has a fault;

wherein the eight carriages in the carriage group are numbered sequentially as a carriage

1 to a carriage 8, the auxiliary power supply system comprises 4 traction auxiliary converters respectively arranged in the carriage 2, the carriage 4, the carriage 5 and the carriage 7, and comprises 3 circuit breakers connected between the 4 traction auxiliary converters and respectively arranged in the carriage 3, the carriage 5 and the carriage 6; and

wherein the determining a medium voltage alternating current sub-bus that has a fault based on the information on the traction auxiliary converter that reports the bus short-circuit fault comprises:

determining that a medium voltage alternating current sub-bus in the carriage 1 and the carriage 2 has a fault in a case that a traction auxiliary converter in the carriage 2 reports the bus short-circuit information;

determining that a medium voltage alternating current sub-bus in the carriage 3 and the carriage 4 has a fault in a case that a traction auxiliary converter in the carriage 4 reports the bus short-circuit information;

determining that a medium voltage alternating current sub-bus in the carriage 5 and the carriage 6 has a fault in a case that a traction auxiliary converter in the carriage 5 reports the bus short-circuit information; and

determining that a medium voltage alternating current sub-bus in the carriage 7 and the carriage 8 has a fault in a case that a traction auxiliary converter in the carriage 7 reports the bus short-circuit information.

2. The method according to claim 1, after the controlling the traction auxiliary converter that has the internal short-circuit fault to stop operating, further comprising:

S1031: disconnecting, based on a quantity of operating traction auxiliary converters, a portion of alternating current loads of the carriage group gradually in an ascending order of priorities of the alternating current loads to reduce power required by the alternating current loads until the operating traction auxiliary converters meet a power supply requirement of the alternating current loads of the carriage group.

3. The method according to claim 1, wherein the determining whether any one of the traction auxiliary converters has an internal short-circuit fault comprises:

controlling a traction auxiliary converter that reports fault information to stop operating, disconnecting the traction auxiliary converter that reports the fault information from the

medium voltage alternating current sub-buses, and controlling the traction auxiliary converter that reports the fault information to start, by using a PWM pulse, an inverter of the traction auxiliary converter, to determine whether the traction auxiliary converter has the internal short-circuit fault.

~~4. The method according to claim 1, wherein the eight carriages in the carriage group are numbered sequentially as a carriage 1 to a carriage 8, the auxiliary power supply system comprises 4 traction auxiliary converters respectively arranged in the carriage 2, the carriage 4, the carriage 5 and the carriage 7, and comprises 3 circuit breakers connected between the 4 traction auxiliary converters and respectively arranged in the carriage 3, the carriage 5 and the carriage 6; and~~

~~wherein the determining a medium voltage alternating current sub-bus that has a fault based on the information on the traction auxiliary converter that reports the bus short-circuit fault comprises:~~

~~determining that a medium voltage alternating current sub-bus in the carriage 1 and the carriage 2 has a fault in a case that a traction auxiliary converter in the carriage 2 reports the bus short-circuit information;~~

~~determining that a medium voltage alternating current sub-bus in the carriage 3 and the carriage 4 has a fault in a case that a traction auxiliary converter in the carriage 4 reports the bus short-circuit information;~~

~~determining that a medium voltage alternating current sub-bus in the carriage 5 and the carriage 6 has a fault in a case that a traction auxiliary converter in the carriage 5 reports the bus short-circuit information; and~~

~~determining that a medium voltage alternating current sub-bus in the carriage 7 and the carriage 8 has a fault in a case that a traction auxiliary converter in the carriage 7 reports the bus short-circuit information.~~

~~5~~4. The method according to claim ~~4~~1, wherein the controlling operation states of the circuit breakers and operation states of the traction auxiliary converters based on the determined medium voltage alternating current sub-bus that has a fault comprises:

controlling the circuit breaker in the carriage 3 to be opened and the circuit breakers in the carriage 5 and the carriage 6 to be closed, and controlling the traction auxiliary converter

in the carriage 2 to stop operating, in a case that the medium voltage alternating current sub-bus in the carriage 1 and the carriage 2 has a fault;

controlling the circuit breakers in the carriage 3 and the carriage 5 to be opened and the circuit breaker in the carriage 6 to be closed, and controlling the traction auxiliary converter in the carriage 4 to stop operating, in a case that the medium voltage alternating current sub-bus in the carriage 3 and the carriage 4 has a fault;

controlling the circuit breakers in the carriage 5 and the carriage 6 to be opened and the circuit breaker in the carriage 3 to be closed, and controlling the traction auxiliary converter in the carriage 5 to stop operating, in a case that the medium voltage alternating current sub-bus in the carriage 5 and the carriage 6 has a fault;

controlling the circuit breaker in the carriage 6 to be opened and the circuit breakers in the carriage 5 and the carriage 3 to be closed, and controlling the traction auxiliary converter in the carriage 7 to stop operating, in a case that the medium voltage alternating current sub-bus in the carriage 7 and the carriage 8 has a fault;

controlling the circuit breakers in the carriage 3 and the carriage 5 to be opened and the circuit breaker in the carriage 6 to be closed, and controlling the traction auxiliary converters in the carriage 2 and the carriage 4 to stop operating, in a case that the medium voltage alternating current sub-bus in the carriage 1 and the carriage 2 has a fault and the medium voltage alternating current sub-bus in the carriage 3 and the carriage 4 has a fault;

controlling all the circuit breakers to be opened, and controlling the traction auxiliary converters in the carriage 2 and the carriage 5 to stop operating, in a case that the medium voltage alternating current sub-bus in the carriage 1 and the carriage 2 has a fault and the medium voltage alternating current sub-bus in the carriage 5 and the carriage 6 has a fault;

controlling the circuit breakers in the carriage 3 and the carriage 6 to be opened and the circuit breaker in the carriage 5 to be closed, and controlling the traction auxiliary converters in the carriage 2 and the carriage 7 to stop operating, in a case that the medium voltage alternating current sub-bus in the carriage 1 and the carriage 2 has a fault and the medium voltage alternating current sub-bus in the carriage 7 and the carriage 8 has a fault;

controlling all the circuit breakers to be opened, and controlling the traction auxiliary converters in the carriage 4 and the carriage 5 to stop operating, in a case that the medium voltage alternating current sub-bus in the carriage 3 and the carriage 4 has a fault and the

medium voltage alternating current sub-bus in the carriage 5 and the carriage 6 has a fault;

controlling all the circuit breakers to be opened, and controlling the traction auxiliary converters in the carriage 4 and the carriage 7 to stop operating, in a case that the medium voltage alternating current sub-bus in the carriage 3 and the carriage 4 has a fault and the medium voltage alternating current sub-bus in the carriage 7 and the carriage 8 has a fault;

controlling the circuit breakers in the carriage 5 and the carriage 6 to be opened and the circuit breaker in the carriage 3 to be closed, and controlling the traction auxiliary converters in the carriage 5 and the carriage 7 to stop operating, in a case that the medium voltage alternating current sub-bus in the carriage 5 and the carriage 6 has a fault and the medium voltage alternating current sub-bus in the carriage 7 and the carriage 8 has a fault;

controlling all the circuit breakers to be opened, and controlling the traction auxiliary converters in the carriage 4, the carriage 5 and the carriage 7 to stop operating, in a case that the medium voltage alternating current sub-bus in the carriage 3 and the carriage 4, the medium voltage alternating current sub-bus in the carriage 5 and the carriage 6 and the medium voltage alternating current sub-bus in the carriage 7 and the carriage 8 each have a fault;

controlling all the circuit breakers to be opened, and controlling the traction auxiliary converters in the carriage 2, the carriage 5 and the carriage 7 to stop operating, in a case that the medium voltage alternating current sub-bus in the carriage 1 and the carriage 2, the medium voltage alternating current sub-bus in the carriage 5 and the carriage 6 and the medium voltage alternating current sub-bus in the carriage 7 and the carriage 8 each have a fault;

controlling all the circuit breakers to be opened, and controlling the traction auxiliary converters in the carriage 2, the carriage 4 and the carriage 7 to stop operating, in a case that the medium voltage alternating current sub-bus in the carriage 1 and the carriage 2, the medium voltage alternating current sub-bus in the carriage 3 and the carriage 4 and the medium voltage alternating current sub-bus in the carriage 7 and the carriage 8 each have a fault;

controlling all the circuit breakers to be opened, and controlling the traction auxiliary converters in the carriage 2, the carriage 4 and the carriage 5 to stop operating, in a case that

the medium voltage alternating current sub-bus in the carriage 3 and the carriage 4, the medium voltage alternating current sub-bus in the carriage 5 and the carriage 6 and the medium voltage alternating current sub-bus in the carriage 1 and the carriage 2 each have a fault; and

controlling all the circuit breakers to be opened and controlling all the traction auxiliary converters to stop operating in a case that each of the medium voltage alternating current sub-buses has a fault.

~~6~~5. A system for controlling a medium voltage alternating current bus, applied to an auxiliary power supply system of a high-speed multiple-unit train, the high-speed multiple-unit train comprising at least one carriage group each comprising eight carriages, the auxiliary power supply system comprising a plurality of traction auxiliary converters arranged in different carriages and a plurality of circuit breakers connected between the plurality of traction auxiliary converters, the plurality of traction auxiliary converters forming an entire medium voltage alternating current bus, the plurality of circuit breakers dividing the entire medium voltage alternating current bus into a plurality of medium voltage alternating current sub-buses, and the system for controlling a medium voltage alternating current bus comprising a first determining module, a second determining module, a first controlling module, a second controlling module, a fault determining module, and a third controlling module, wherein

the first determining module is configured to determine whether the bus has a short-circuit fault, control all the circuit breakers to be closed and control all the traction auxiliary converters to operate if the bus has no short-circuit fault, and trigger the second determining module if the bus has a short-circuit fault;

the second determining module is configured to determine whether any one of the traction auxiliary converters has an internal short-circuit fault, trigger the first controlling module if one of the traction auxiliary converters has the internal short-circuit fault, and trigger the second controlling module if no one of the traction auxiliary converters has the internal short-circuit fault;

the first controlling module is configured to control the traction auxiliary converter that has the internal short-circuit fault to stop operating;

the second controlling module is configured to open all the circuit breakers, perform a short-circuit test on each of the medium voltage alternating current sub-buses, and acquire information on a traction auxiliary converter that reports a bus short-circuit fault;

the fault determining module is configured to determine a medium voltage alternating current sub-bus that has a fault based on the information on the traction auxiliary converter that reports the bus short-circuit fault; and

the third controlling module is configured to control operation states of the circuit breakers and operation states of the traction auxiliary converters based on the determined medium voltage alternating current sub-bus that has a fault;

wherein the eight carriages in the carriage group are numbered sequentially as a carriage 1 to a carriage 8, the auxiliary power supply system comprises 4 traction auxiliary converters respectively arranged in the carriage 2, the carriage 4, the carriage 5 and the carriage 7, and comprises 3 circuit breakers connected between the 4 traction auxiliary converters and respectively arranged in the carriage 3, the carriage 5 and the carriage 6, wherein the fault determining module is configured to:

determine that a medium voltage alternating current sub-bus in the carriage 1 and the carriage 2 has a fault in a case that a traction auxiliary converter in the carriage 2 reports the bus short-circuit information;

determine that a medium voltage alternating current sub-bus in the carriage 3 and the carriage 4 has a fault in a case that a traction auxiliary converter in the carriage 4 reports the bus short-circuit information;

determine that a medium voltage alternating current sub-bus in the carriage 5 and the carriage 6 has a fault in a case that a traction auxiliary converter in the carriage 5 reports the bus short-circuit information; and

determine that a medium voltage alternating current sub-bus in the carriage 7 and the carriage 8 has a fault in a case that a traction auxiliary converter in the carriage 7 reports the bus short-circuit information.

~~7~~6. The system according to claim ~~6~~6, further comprising:

a load balancing module configured to disconnect, based on a quantity of operating traction auxiliary converters, a portion of alternating current loads of the carriage group

gradually in an ascending order of priorities of the alternating current loads to reduce power required by the alternating current loads until the operating traction auxiliary converters meet a power supply requirement of the alternating current loads of the carriage group.

~~8~~7. The system according to claim ~~6~~5, wherein the second determining module being configured to determine whether any one of the traction auxiliary converters has an internal short-circuit fault comprises the second determining module being configured to:

control a traction auxiliary converter that reports fault information to stop operating, disconnect the traction auxiliary converter that reports the fault information from the medium voltage alternating current sub-buses, and control the traction auxiliary converter that reports the fault information to start, by using a PWM pulse, an inverter of the traction auxiliary converter, to determine whether the traction auxiliary converter has the internal short-circuit fault.

~~9. The system according to claim 6, wherein the eight carriages in the carriage group are numbered sequentially as a carriage 1 to a carriage 8, the auxiliary power supply system comprises 4 traction auxiliary converters respectively arranged in the carriage 2, the carriage 4, the carriage 5 and the carriage 7, and comprises 3 circuit breakers connected between the 4 traction auxiliary converters and respectively arranged in the carriage 3, the carriage 5 and the carriage 6, wherein the fault determining module is configured to:~~

~~determine that a medium voltage alternating current sub-bus in the carriage 1 and the carriage 2 has a fault in a case that a traction auxiliary converter in the carriage 2 reports the bus short-circuit information;~~

~~determine that a medium voltage alternating current sub-bus in the carriage 3 and the carriage 4 has a fault in a case that a traction auxiliary converter in the carriage 4 reports the bus short-circuit information;~~

~~determine that a medium voltage alternating current sub-bus in the carriage 5 and the carriage 6 has a fault in a case that a traction auxiliary converter in the carriage 5 reports the bus short-circuit information; and~~

~~determine that a medium voltage alternating current sub-bus in the carriage 7 and the carriage 8 has a fault in a case that a traction auxiliary converter in the carriage 7 reports the bus short-circuit information.~~

~~10~~8. The system according to claim ~~9~~5, wherein the third controlling module is configured to:

control the circuit breaker in the carriage 3 to be opened and the circuit breakers in the carriage 5 and the carriage 6 to be closed, and control the traction auxiliary converter in the carriage 2 to stop operating, in a case that the medium voltage alternating current sub-bus in the carriage 1 and the carriage 2 has a fault;

control the circuit breakers in the carriage 3 and the carriage 5 to be opened and the circuit breaker in the carriage 6 to be closed, and control the traction auxiliary converter in the carriage 4 to stop operating, in a case that the medium voltage alternating current sub-bus in the carriage 3 and the carriage 4 has a fault;

control the circuit breakers in the carriage 5 and the carriage 6 to be opened and the circuit breaker in the carriage 3 to be closed, and control the traction auxiliary converter in the carriage 5 to stop operating, in a case that the medium voltage alternating current sub-bus in the carriage 5 and the carriage 6 has a fault;

control the circuit breaker in the carriage 6 to be opened and the circuit breakers in the carriage 5 and the carriage 3 to be closed, and control the traction auxiliary converter in the carriage 7 to stop operating, in a case that the medium voltage alternating current sub-bus in the carriage 7 and the carriage 8 has a fault;

control the circuit breakers in the carriage 3 and the carriage 5 to be opened and the circuit breaker in the carriage 6 to be closed, and control the traction auxiliary converters in the carriage 2 and the carriage 4 to stop operating, in a case that the medium voltage alternating current sub-bus in the carriage 1 and the carriage 2 has a fault and the medium voltage alternating current sub-bus in the carriage 3 and the carriage 4 has a fault;

control all the circuit breakers to be opened, and control the traction auxiliary converters in the carriage 2 and the carriage 5 to stop operating, in a case that the medium voltage alternating current sub-bus in the carriage 1 and the carriage 2 has a fault and the medium voltage alternating current sub-bus in the carriage 5 and the carriage 6 has a fault;

control the circuit breakers in the carriage 3 and the carriage 6 to be opened and the circuit breaker in the carriage 5 to be closed, and control the traction auxiliary converters in the carriage 2 and the carriage 7 to stop operating, in a case that the medium voltage alternating current sub-bus in the carriage 1 and the carriage 2 has a fault and the medium

voltage alternating current sub-bus in the carriage 7 and the carriage 8 has a fault;

control all the circuit breakers to be opened, and control the traction auxiliary converters in the carriage 4 and the carriage 5 to stop operating, in a case that the medium voltage alternating current sub-bus in the carriage 3 and the carriage 4 has a fault and the medium voltage alternating current sub-bus in the carriage 5 and the carriage 6 has a fault;

control all the circuit breakers to be opened, and control the traction auxiliary converters in the carriage 4 and the carriage 7 to stop operating, in a case that the medium voltage alternating current sub-bus in the carriage 3 and the carriage 4 has a fault and the medium voltage alternating current sub-bus in the carriage 7 and the carriage 8 has a fault;

control the circuit breakers in the carriage 5 and the carriage 6 to be opened and the circuit breaker in the carriage 3 to be closed, and control the traction auxiliary converters in the carriage 5 and the carriage 7 to stop operating, in a case that the medium voltage alternating current sub-bus in the carriage 5 and the carriage 6 has a fault and the medium voltage alternating current sub-bus in the carriage 7 and the carriage 8 has a fault;

control all the circuit breakers to be opened, and control the traction auxiliary converters in the carriage 4, the carriage 5 and the carriage 7 to stop operating, in a case that the medium voltage alternating current sub-bus in the carriage 3 and the carriage 4, the medium voltage alternating current sub-bus in the carriage 5 and the carriage 6 and the medium voltage alternating current sub-bus in the carriage 7 and the carriage 8 each have a fault;

control all the circuit breakers to be opened, and control the traction auxiliary converters in the carriage 2, the carriage 5 and the carriage 7 to stop operating, in a case that the medium voltage alternating current sub-bus in the carriage 1 and the carriage 2, the medium voltage alternating current sub-bus in the carriage 5 and the carriage 6 and the medium voltage alternating current sub-bus in the carriage 7 and the carriage 8 each have a fault;

control all the circuit breakers to be opened, and control the traction auxiliary converters in the carriage 2, the carriage 4 and the carriage 7 to stop operating, in a case that the medium voltage alternating current sub-bus in the carriage 1 and the carriage 2, the medium voltage alternating current sub-bus in the carriage 3 and the carriage 4 and the medium voltage alternating current sub-bus in the carriage 7 and the carriage 8 each have a fault;

control all the circuit breakers to be opened, and control the traction auxiliary converters

in the carriage 2, the carriage 4 and the carriage 5 to stop operating, in a case that the medium voltage alternating current sub-bus in the carriage 3 and the carriage 4, the medium voltage alternating current sub-bus in the carriage 5 and the carriage 6 and the medium voltage alternating current sub-bus in the carriage 1 and the carriage 2 each have a fault; and

control all the circuit breakers to be opened and control all the traction auxiliary converters to stop operating in a case that each of the medium voltage alternating current sub-buses has a fault.