

INTEGRATED AUXILIARY CONVERTER WITH HIGH POWER DENSITY

5 **CROSS-REFERENCE TO RELATED APPLICATIONS**

The present application claims the priority of the Chinese patent application No. CN202111152139.4 filed on September 29, 2021, the entirety of which is incorporated herein by reference.

10 **Field of the invention**

The present application relates to the technical field of auxiliary converters, and in particular, to an integrated auxiliary converter with high power density.

Background of the invention

15 With rapid development of national rail transit industry, an auxiliary converter as an important power supply unit of a train has been continuously upgraded, an original bulky converter device has been gradually replaced by a small and efficient converter. At the same time, serialized and standardized urban rail transit is also gradually developing into a unified model. For serialized standard auxiliary converter
20 equipment, it is urgent to design a converter with a universal mounting interface, reasonable layout of outgoing lines and excellent performance indicators, so as to further improve universality of a product, reduce a loss of the product, improve efficiency, and meet national strategic requirements of peak carbon dioxide emissions and carbon neutrality.

25 At present, an eight-marshall subway vehicle on the market applies a grid-connected power supply method, and a subway auxiliary converter has a capacity of 180 kVA (including a 16 kW charger). There are two implementations:

A power frequency solution is adopted. A single power frequency auxiliary converter has a weight of 1300 kg, considering that a loss of one auxiliary converter
30 does not reduce a load capacity, a whole vehicle often needs to be equipped with four auxiliary converters, and the auxiliary converters of the whole vehicle have a weight of 5200 kg. Such auxiliary converters may meet a mounting demand of the whole vehicle being lapped with large side beams and high-voltage and low-voltage line arrangement requirements of the vehicle. However, if the solution is adopted, a

vehicle auxiliary system is high in weight, low in efficiency (about 90%), and high in energy consumption, which is not conducive to energy conservation of the system, and thus tending to be not favored by customers.

5 A high-frequency solution is adopted. A soft-switching technology is adopted, and a full container adopts a long strip-shaped arrangement. A single container has a weight of 650 kg. If an eight-marshall vehicle adopts grid-connected power supply, auxiliary converters of the whole vehicle have a weight of 2600 kg. Thus, an auxiliary weight of the whole vehicle is reduced by 2600 kg, a reduction of 50%. However, if such structural form is adopted, there are two problems. First, the structure of the whole vehicle being lapped with the large side beams cannot be met; and second, 10 crossing is present during high-voltage line and low-voltage line arrangement, which is not conducive to line arrangement of the whole vehicle. If a square arrangement is adopted to meet the structure of the whole vehicle being lapped with the large side beams, the weight of a container body is increased by about 40-50 kg, which does not 15 meet the demand for light weight.

In order to solve the problems of the above existing solutions, it is necessary to design an integrated auxiliary converter with high power density, which meets a requirement of vehicle lightweight, and at the same time, takes into account relevant requirements of power density, vehicle line outgoing positions, whole vehicle being 20 lapped with large side beams, and heat dissipation.

Summary of the invention

In order to solve the problem that it is difficult for an auxiliary converter in the prior art to simultaneously meet demands of light weight and power density and the 25 problem of routing, the present application provides an integrated auxiliary converter with high power density.

An integrated auxiliary converter with high power density of the present application includes two converter modules disposed in a same case, wherein a plurality of functional modules in each converter module are overall of a linear layout 30 structure distributed in one direction, and the two converter modules are laid out in the case in a mirrored manner; and

the functional modules corresponding to an input end and an output end of a circuit structure of each converter module are located at two ends of the

corresponding linear layout structure respectively, and side walls of two opposite sides of the case corresponding to the two ends of each linear layout structure are provided with an input wiring structure and an output wiring structure respectively.

5 In an implementation, lines at the input ends and/or the output ends of the two converter modules are arranged in the case in parallel and then connected to the corresponding line connecting structures.

10 In an implementation, the output end of each converter module is provided with a direct-current output portion and an alternating-current output portion, and the direct-current output portions and the alternating-current output portions of the two converter modules are respectively connected in parallel in the case and then output through the corresponding output line connecting structures.

In an implementation, the output line connecting structures respectively corresponding to the direct-current output portions and the alternating-current output portions are located at two ends on a side wall of a same side of the case.

15 In an implementation, an interior of the case is divided into two mounting areas for mounting the converter modules, each mounting area is sequentially separated into a relatively independent first assembly region, second assembly region and third assembly region in a direction of the corresponding linear layout structure, so as to mount the corresponding functional modules respectively.

20 In an implementation, each mounting area is internally provided with a heat-dissipating duct, the heat-dissipating duct is provided with an air inlet and air outlets, the air inlet corresponds to the second assembly region, and the air outlets are provided at a bottom of the case corresponding to the first assembly region and the third assembly region respectively;

25 wherein cooling air input through the air inlet passes through the second assembly region, then enters the first assembly region and third assembly region respectively, and is output through the corresponding air outlets.

30 In an implementation, the two mounting areas are spaced by a certain distance, and the corresponding assembly regions of the two mounting areas correspond to the independent air outlets respectively; or

the two mounting areas are adjacent, and the two corresponding adjacent assembly regions of the two mounting areas share one of the air outlets.

In an implementation, the two heat-dissipating ducts corresponding to the two mounting areas are provided with fans respectively, and the fans are disposed in the

second assembly regions; or

the two heat-dissipating ducts corresponding to the two mounting areas share one fan, the two second assembly regions of the two mounting areas communicate with each other, and the fan is disposed at an intersection of the two second assembly regions.

In an implementation, in a case that the two heat-dissipating ducts are provided with the fans respectively, each fan is embedded in the corresponding air inlet, or each fan directly faces the corresponding air inlet and is at a certain distance from the corresponding air inlet.

In an implementation, each of the first assembly regions and the third assembly regions is separated into a first assembly cavity and a second assembly cavity that are relatively independent, and the air outlets correspond to the second assembly cavities; and

the first assembly cavities and the second assembly cavities communicate with the second assembly regions respectively through the air inlets corresponding thereto, and the first assembly cavities and the second assembly cavities communicate with each other through ventilation openings at ends away from the air inlets.

In an implementation, the air inlets corresponding to the first assembly cavities have a circulation area greater than that of the air inlets corresponding to the second assembly cavities.

In an implementation, a middle partition plate is disposed between the two mounting areas; and

the middle partition plate overall isolates the first to third assembly regions of the two mounting areas, or the middle partition plate only isolates the two second assembly regions of the two mounting areas.

In an implementation, filtering devices are disposed at the air inlets, and provided with dust discharge outlets to discharge filtered and accumulated dust.

In an implementation, the case has a rectangular shape, a width of the case in a first direction is adapted to a width of a corresponding train body, and edges of two sides of the case in the first direction are further provided with lifting lugs for being connected to side-face beams of the train body; and

the first direction is perpendicular to a direction from one of the converter modules to the other converter module.

The above technical features may be combined in various suitable ways or

replaced by equivalent technical features, as long as the objective of the present application can be achieved.

Compared with the prior art, the integrated auxiliary converter with high power density provided by the present application at least has the following beneficial effects that:

the integrated auxiliary converter with high power density according to the present application integrates the two converter modules into a whole, and through layout design, ensures that an overall width size is matched with a width of a train body and adapted to mounting structures of side-face beams of a train, such that in a case that a requirement of convenient mounting is met, requirements of light weight and power density are met at the same time. In addition, the two converter modules are of a linear and overall mirrored layout structure, and an internal structure of the case, a region division structure and materials are completely simplified and unified; and at the same time, the lines come in from one side and go out from the other side, and the two converter modules have a consistent routing direction, which facilitates routing of the whole train.

Brief Description of the Drawings

The present will be described in more detail below based on the embodiments and with reference to the drawings. Wherein

Fig. 1 shows a stereogram of a structure of an auxiliary converter according to the present application (two converter modules are adjacent);

Fig. 2 shows a top view of the structure shown in Fig. 1;

Fig. 3 shows a schematic diagram of a flow direction of cooling air in heat-dissipating ducts of the auxiliary converter according to the present application;

Fig. 4 shows a schematic structural diagram of a cross section in an A-A direction in Fig. 3;

Fig. 5 shows a schematic structural diagram of a cross section in a B-B direction in Fig. 3;

Fig. 6 shows a schematic structural diagram of a cross section in a C-C direction in Fig. 3;

Fig. 7 shows a schematic structural diagram of a cross section in a D-D direction in Fig. 3;

Fig. 8 shows a schematic diagram of another structure of an auxiliary converter

according to the present application (two converter modules are spaced by a certain distance); and

Fig. 9 shows a principle diagram of circuit structures of an auxiliary converter according to the present application.

5 In the drawings, identical components use identical reference signs. The drawings are not drawn to actual scale.

Reference signs:

10 10 - case, 11 - input line connecting structure, 12 - output line connecting structure, 121 - direct-current copper bus bar, 122 - direct-current filter, 123 - alternating-current output contactor, 124 - alternating-current output confluence, 125 - alternating-current filter, 13 - air inlet, 14 - air outlet, 15 - middle partition plate, 16 - lifting lug, 17 - cavity partition plate, 20 - converter module, 21 - HVM module, 22 - high-frequency transformer, 23 - input inductor, 24 - LVM module, 25 - three-phase inductor, 30 - mounting area, 301 - first assembly cavity, 302 - second assembly cavity, 15 303 - air inlet, 304 - ventilation opening, 31 - first assembly region, 32 - second assembly region, 321 - fan, 33 - third assembly region, and 40 - filtering device.

Detailed Description of the Embodiments

20 The present application will be further illustrated below in conjunction with the drawings.

An embodiment of the present application provides an integrated auxiliary converter with high power density. The integrated auxiliary converter includes two converter modules 20 disposed in a same case 10, a plurality of functional modules in each converter module 20 are overall of a linear layout structure distributed in one direction, and the two converter modules 20 are overall laid out in the case in a mirrored manner; and

30 the functional modules corresponding to an input end and an output end of a circuit structure of each converter module 20 are located at two ends of the corresponding linear layout structure respectively, and side walls of two opposite sides of the case 10 corresponding to the two ends of each linear layout structure are provided with an input line connecting structure 11 and an output line connecting structure 12 respectively.

Specifically, as shown in Fig. 1 and Fig. 2, the auxiliary converter according to the present application includes two converter modules 20, each converter module 20

has a complete voltage conversion function, and the two converter modules 20 are disposed in the same case 10. Each converter module 20 is provided with a plurality of functional modules, and referring to Fig. 9, the functional modules include an HVM module 21 (including a boost circuit unit and a resonant transformation unit), an LVM module 24 (including an AC/DC rectification circuit, an API circuit and an LVPS circuit), a high-frequency transformer 22, a chopper inductor, an input inductor 23, a charger magnetic component and a three-phase inductor. The plurality of functional modules are overall of a linear layout structure in the case 10, and an arrangement order of the functional modules in the linear layout structure roughly refers to an arrangement order of the functional modules in a direction from the input end to the output end in the corresponding circuit structure. It is at least ensured that the main functional modules corresponding to the input end and the output end of each circuit structure are located at two ends of the corresponding linear layout structure respectively (i.e., each HVM module 21 is close to the corresponding input end, and each LVM module 24 is close to the corresponding output end), the two ends of each linear layout structure are close to the side walls of the two opposite sides of the case 10 respectively, the side walls of the two sides are provided with an input line connecting structure 11 and an output line connecting structure 12 respectively, which may facilitate line incoming and outgoing of the converter modules 20, i.e., lines come in from one side and go out from the other side, so as to facilitate routing.

The two converter modules 20 are disposed on the two sides of the interior of the case 10 respectively, and the linear layout structures of the two converter modules 20 are overall parallel to each other and mirrored. In this way, the input ends and the output ends of the two converter modules 20 are located on the side face of the same side of the case 10 respectively, and the two side faces where the input ends and the output ends are located correspond to an opposite set of side walls of the case 10, so that the whole auxiliary converter realizes that the lines come into one side and go out from the other side, and the lines are not significantly crossed, which is conducive to line arrangement of the whole vehicle. Moreover, after the two converter modules 20 adopt the liner and mirrored layout structures shown in the drawings, a width of the case 10 may be matched with a width of a train body, so that side-face beams of the vehicle body may be directly connected without additional cross beams, which simplifies a mounting structure and realizes light weight.

In addition, the two converter modules 20 are completely disposed in the case in

the mirrored manner, and thus corresponding assembly structures in the case 10 and an overall layout are also completely mirrored, so that the converter modules 20 themselves and other devices and structures in the case 10 are completely simplified and unified. Moreover, regions where the two converter modules 20 are located are relatively independent, the modules of the two converter modules 20 are not distributed in a crossed manner, and the overall layout is clear, which facilitates assembly of the auxiliary converter.

In one embodiment, lines at the input ends and/or the output ends of the two converter modules 20 are arranged in the case 20 in parallel and then connected to the corresponding line connecting structures.

Specifically, based on a principle diagram of circuit structures shown in Fig. 9, the two converter modules 20 are originally required to perform parallel outputting, so the output ends of the two converter modules 20 are further connected in the case 10 in parallel and then perform outputting. In this way, a usage quantity of cables may be reduced to the maximum extent, costs are saved, an overall weight of the converter is reduced, and one cable is reduced, which is conducive to line arrangement of the whole vehicle.

In addition, the two converter modules 20 have the same input voltage, so the input ends of the two converter modules 20 may also be directly arranged together in parallel, i.e., connected to an external cable through the same input line connecting structure 11, and a current is input and then shunted and input into the two converter modules 20 respectively. In this way, the corresponding technical effect may also be achieved.

In one embodiment, the output end of each converter module 20 is provided with a direct-current output portion and an alternating-current output portion, and the direct-current output portions and the alternating-current output portions of the two converter modules 20 are respectively connected in the case 10 in parallel and then output through the corresponding output line connecting structures 12.

Specifically, referring to Fig. 9, the auxiliary converter can output an alternating current and a direct current at the same time, so the output ends of the converter modules 20 are provided with the direct-current output portions and the alternating-current output portions. Thus, for parallel outputting of the output ends of the two converter modules 20, the two direct-current output portions are mutually connected in parallel, the two alternating-current output portions are mutually

connected in parallel, and the direct-current output portions connected in parallel and the alternating-current output portions connected in parallel perform outputting through one output line connecting structure 12 respectively.

In one embodiment, the output line connecting structures 12 respectively
5 corresponding to the direct-current output portions and the alternating-current output portions are located at two ends on a side wall of a same side of the case 10.

Specifically, referring to Fig. 1 and Fig. 2, the direct-current output portions and the alternating-current output portions correspond to the side face of the same side of the case 10, and overall positions of the direct-current output portions and the
10 alternating-current output portions and the output line connecting structures 12 respectively corresponding to the direct-current output portions and the alternating-current output portions are located at the two ends of the side wall of the side of the case 10. That is, the direct-current output portions and the alternating-current output portions are spaced by a certain safety distance to avoid
15 mutual interference.

In one embodiment, an interior of the case 10 is divided into two mounting areas 30 for mounting the converter modules 20, each mounting area 30 is sequentially separated into a relatively independent first assembly region 31, second assembly region 32 and third assembly region 33 in a direction of the corresponding linear
20 layout structure, so as to mount the corresponding functional modules respectively.

Specifically, referring to Fig. 1 and Fig. 2, the case 10 is internally provided with the mounting areas 30 for mounting the converter modules 20, and each mounting area 30 is separated into a plurality of corresponding assembly regions to mount the corresponding functional modules respectively. Specifically, an HVM module 21, a
25 high-frequency transformer 22 and a chopper inductor are mounted in the first assembly region, an input inductor 23 is mounted in the second assembly region 32, and an LVM module 24, a charger magnetic component and a three-phase inductor 25 are mounted in the third assembly region 33. In this way, the functional modules are assembled in separate regions, so that the structural layout of the converter modules
30 20 is clear at a glance, which facilitates assembly and routing.

In one embodiment, each mounting area 30 is internally provided with a heat-dissipating duct, the heat-dissipating duct is provided with an air inlet 13 and air outlets 14, the air inlet 13 corresponds to the second assembly region 32, and the air outlets 14 are provided at a bottom of the case 10 corresponding to the first assembly

region 31 and the third assembly region 33 respectively;

wherein cooling air input through the air inlet 13 passes through the second assembly region 32, then enters the first assembly region 31 and third assembly region 33 respectively, and is output through the corresponding air outlets 14.

5 Specifically, referring to Fig. 2 to Fig. 4, the first assembly regions to third assembly regions 33 in the mounting area 30 are designed in a separated manner, and at the same time, the heat-dissipating duct is formed. The heat-dissipating duct is not formed through a large-scale targeted design, but is obtained by being slightly optimized on the basis of a naturally formed structure of a region division structure of
10 a layout of the functional modules corresponding to the mounting area 30. Thus, the heat-dissipating duct has a pretty compact structure, which ensures that an auxiliary converter product has high power density. The air inlet 13 is located on a side wall of the case 10 corresponding to the second assembly region 32 and directly faces a fan 321 in the second assembly region 32, and there are two air outlets 14, which are
15 located on a bottom wall face of the case 10 corresponding to the first assembly region 31 and the third assembly region 33 respectively.

Under guidance of the fan 321, the cooling air first enters the second assembly region 32 through the air inlet 13 to cool the input inductor 23 in the second assembly region 32, and then under guidance of partition plates between the assembly regions,
20 the cooling air flows from the second assembly region 32 towards the two sides to enter the first assembly region 31 and the third assembly region 33 respectively and finally is discharged from the air outlets 14 corresponding to the first assembly region 31 and the third assembly region 33. An overall flow direction of the cooling air is in a T shape. The two converter modules 20 are provided with the independent
25 heat-dissipating ducts and fans 321 respectively, and do not interfere with each other.

In one embodiment, the two mounting areas 30 are spaced by a certain distance, and the corresponding assembly regions of the two mounting areas 30 correspond to the independent air outlets 14 respectively; or

the two mounting areas 30 are adjacent, and the two corresponding adjacent
30 assembly regions of the two mounting areas 30 share one air outlet 14.

Specifically, referring to Fig. 3, the two mounting areas 30 corresponding to the two converter modules 20 are adjacent, thus the two first assembly regions 31 of the two mounting areas 30 are adjacent, and the two third assembly regions 33 are adjacent. Therefore, in order to simplify the structure of the case 10, the two adjacent

mounting areas 30 may share one air outlet 14. The air outlet 14 overall includes a plurality of densely distributed air outlet holes, and a distribution range of the air outlet holes simultaneously covers the two adjacent corresponding mounting areas 30. By adopting the structure shown in Fig. 3, the whole converter has a more compact structure, the size of the case 10 is the minimum. However, in order to be adapted to the mounting width of the train body, lengths of lifting lugs 16 need to be increased.

Referring to Fig. 4, the two mounting areas 30 corresponding to the two converter modules 20 are spaced by a certain distance, so both the two first assembly regions 31 and the two third assembly regions 33 of the two mounting areas 30 are spaced by a certain distance, which is inconvenient to share the air outlet 14, so the air outlets 14 are provided corresponding to each corresponding mounting area 30. By adopting the structure shown in Fig. 4, the whole converter has a slightly loose structure, and there is sufficiently rich space between the modules, which facilitates the structural layout and operations of assembly and routing. At this time, the size of the case 10 is the optimum size that is adapted to the mounting width of the train body, the lifting lugs 16 do not need to be lengthened, or even lifting structures may be constructed directly at edges of a body of the case 10.

In one embodiment, the two-dissipating ducts corresponding to the two mounting areas 30 are provided with fans 321 respectively, and the fans 321 are disposed in second assembly regions; or

the two heat-dissipating ducts corresponding to the two mounting areas 30 share one fan 321, the two second assembly regions 32 of the two mounting areas 30 communicate with each other, and the fan 321 is disposed at an intersection of the two second assembly regions 32.

Specifically, referring to Fig. 3 or Fig. 4, airflow power sources of the heat-dissipating ducts are the fans 321, the fans 321 guide outside cold air from the air inlets 13 into the second assembly regions 32 of the case 10 to flow along orientations of the heat-dissipating ducts. The fans 321 may be disposed in the two heat-dissipating ducts respectively, so that the two heat-dissipating ducts may operate completely independently.

At the same time, if the problem of energy conservation is taken into account, the two heat-dissipating ducts may share one fan 321. At this time, the structures of the heat-dissipating ducts need to be finely adjusted, that is, the two second assembly regions 32 of the two heat-dissipating ducts need to communicate with each other.

The fans 321 are disposed at the intersection of the two second assembly regions 32. At this time, a two-way air intake fan 321 (a centrifugal fan) needs to be adopted. If the structure shown in Fig. 3 is adopted, the two-way air intake fan 321 is disposed at an adjacent point of the two second assembly regions 32 (a central position of the case 10). If the structure shown in Fig. 4 is adopted, the two-way air intake fan 321 may be disposed in a blank region between the two second assembly regions 32 (the central position of the case 10). As for the two-way air intake fan 321, two gas inlets of the two-way air intake fan 321 correspond to the two air inlets 13 on the case 10, and at the same time, two gas outlets may be provided in the fan 321 and are arranged at 90° relative to the gas inlets, so as to correspond to the first assembly regions 31 and the third assembly regions 33 on the two sides of the two second assembly region 32 respectively.

Further, as for the structure shown in Fig. 4, there is the blank region between the two mounting areas 30, then it is also possible to dispose the fan in the center of the blank region and cancel the original two air inlets 13, and at the same time, an air inlet is formed in the top or bottom of the region and corresponds to the fan. In this way, the two heat-dissipating ducts corresponding to the two converter modules 20 share one air inlet structure and one air inlet power, which saves energy and further simplifies the structure of the converter.

In one embodiment, in a case that the two heat-dissipating ducts are provided with the fans 321 respectively, each fan 321 is embedded in the corresponding air inlet 13, or the each fan 321 directly faces the corresponding air inlet 13 and is at a certain distance from the corresponding air inlet 13.

Specifically, as shown in Fig. 3, the fan 321 directly faces the air inlet 13 and is at a certain distance from the air inlet 13. Under the structure, the fan 321 is located inside the second assembly region 32, when an airflow enters the second assembly region 32 from the air inlet 13, part of the airflow directly diverges at the front end of the fan 321 towards the first assembly region 31 and the third assembly region 33 on the two sides, and the other part of the airflow may pass through the fan 321 before diverging towards the first assembly region 31 and the third assembly region 33.

In addition, if the fan 321 is embedded in the air inlet 13, all the airflow passes through the fan 321 and then enters the second assembly region 32, and diverges towards the first assembly region 31 and the third assembly region 33 on the two sides under the action of a flow guiding structure of the second assembly region 32. In this

case, the fan 321 may also be reversely disposed. That is, the airflow reversely flows, and the airflow is input from the air outlet 14 and output from the air inlet 13, which changes the flow direction of the airflow but does not affect the heat-dissipating effect. The flow direction of the airflow may be adjusted according to requirements of application scenarios.

In one embodiment, each of the first assembly regions 31 and the third assembly regions 33 is separated into a first assembly cavity 301 and a second assembly cavity 302 that are relatively independent, and the air outlets 14 correspond to the second assembly cavities 302; and

the first assembly cavities 301 and the second assembly cavities 302 communicate with the second assembly regions 32 respectively through the air inlets 303 corresponding thereto, and the first assembly cavities 301 and the second assembly cavities 302 communicate with each other through ventilation openings 304 at ends away from the air inlets 303.

Specifically, referring to Fig. 5 and Fig. 7, the first assembly cavities 301 and the second assembly cavities 302 are mutually separated through cavity partition plates 17. The first assembly regions 31 have HVM modules 21 mounted in the first assembly cavities 301 and high-frequency transformers 22 and chopper inductors mounted in the second assembly cavities 302. The third assembly regions 33 have LVM modules 24 mounted in the first assembly cavities 301 and charger magnetic components and three-phase inductors mounted in the second assembly cavities 302. In this way, region structures of the first assembly regions 31 and the third assembly regions 33 are further refined, so that the functional modules of the converter modules 20 have clearer layouts, and the layout structures are more simplified and unified.

Referring to Fig. 3, Fig. 4, Fig. 5 and Fig. 7, when entering the first assembly regions 31 and the third assembly regions 33, the cooling air further enters the first assembly cavities 301 and the second assembly cavities 302 respectively through the corresponding air inlets 303, and after flowing through the first assembly cavities 301, the cooling air enters the second assembly cavities 302 through the ventilation openings 304, which may further perform heat dissipation on the devices in the second assembly cavities 302. Finally, the cooling air is discharged from the air outlets 14 corresponding to the second assembly cavities 302.

In this way, the functional modules in the first assembly cavities 301 and the second assembly cavities 302 independently dissipate heat respectively, and the

modules may be combined according to amounts of heat generated, and then disposed in the different assembly cavities, so that the amount of heat generated in each assembly cavity is relatively average, and the amounts of heat generated at the different positions of the whole converter modules 20 are uniformly distributed to avoid an excessively large amount of local heat generated, which is conducive to improving the heat-dissipating effect.

Preferably, the air inlets 303 corresponding to the first assembly cavities 301 have a circulation area greater than that of the air inlets 303 corresponding to the second assembly cavities 302.

Specifically, the HVM module 21 and the LVM module 24 in the two first assembly cavities 301 have maximum amounts of heat generated, so the air inlets 303 corresponding to the two first assembly cavities 301 have a circulation area greater than that of the air inlets 303 corresponding to the second assembly cavities 302, which makes most of the cooling air enter the first assembly cavities 301 to perform heat dissipation on the HVM module 21 and the LVM module 24, so as to ensure the uniformity of overall heat dissipation of the converter modules 20 and improve the heat-dissipating effect.

In one embodiment, in the case 10, a middle partition plate 15 is disposed between the two mounting areas 30; and the middle partition plate 15 overall isolates the first to third assembly regions 33 of the two mounting areas 30, or the middle partition plate 15 only isolates the two second assembly regions 32 of the two mounting areas 30.

Specifically, referring to the structure shown in Fig. 3, the two first assembly regions 31 of the two mounting areas 30 are adjacent, and the two third assembly regions 33 are adjacent and share one air outlet 14. At this time, it is unnecessary to mutually separate the two first assembly regions 31 as well as the two third assembly regions 33, and thus it is unnecessary to dispose the middle partition plate 15, that is, the middle partition plate 15 is only disposed on a section corresponding to the second assembly regions 32, and only isolates the two second assembly regions 32 of the two mounting areas 30.

Referring to the structure shown in Fig. 4, the two mounting areas 30 are mutually separated and independently discharge air, so it is necessary to separate the first to third assembly regions 33 through the middle partition plate 15, that is, the middle partition plate 15 continuously extends from a position corresponding to the

first assembly regions 31 to a position corresponding to the third assembly regions 33, so as to realize complete separation.

It is to be noted that for the solution in which the two heat-dissipating ducts share one fan 321, a vent needs be formed in a position of the middle partition plate 15
5 corresponding to the second assembly regions 32 to facilitate flowing of the airflow and mounting of the fan 321.

In one embodiment, filtering devices 40 are disposed at the air inlets 13, and provided with dust discharge outlets to discharge filtered and accumulated dust.

In one embodiment, the case 10 has a rectangular shape, a width of the case 10 in
10 a first direction is adapted to a width of a corresponding train body, and edges of two sides of the case 10 in the first direction are further provided with lifting lugs 16 for being connected to side-face beams of the train body; and

the first direction is perpendicular to a direction from one of the converter modules 20 to the other converter module 20.

Specifically, the two converter modules 20 are integrated into the same case 10,
15 and through the design of the layout structures of the plurality of functional modules of the converter modules 20, the width of the case 10 in the first direction is adapted to the width of the train body. In this way, the case 10 may be directly connected to the side-face beams of the vehicle body through the lifting lugs 16 without additional
20 cross beams for connection, which simplifies the connecting structure and reduces the overall weight of the auxiliary converter, and at the same time, meets the requirements of light weight and power density.

In this way, the overall routing direction from the input ends to the output ends of the converter modules 20 is also a driving direction of the train, i.e., a length direction
25 of a compartment, and there is sufficient space in the direction, which is conducive to arrangement of routed lines of the whole vehicle.

In one embodiment, referring to Fig. 6 and Fig. 8, output circuit structures are disposed in the case 10 corresponding to a side where the output line connecting structures 12 are located. As for the direct-current output portions, the output circuit
30 structures include direct-current copper bus bars 121 of parallel line portions and direct-current filters 122, and direct currents are connected in parallel through the direct-current copper bus bars 121 and then output through the direct-current filters 122. As for the alternating-current output portions, the output circuit structures include alternating-current output contactors 123 disposed on alternating-current copper bars.

The two converter modules 20 correspond to the alternating-current output contactors 123 respectively. Alternating currents pass through the alternating-current output contactors 123 and then connected in parallel at alternating-current output confluences 124, and finally pass through alternating-current filters 125 and then are output.

5 In addition, the auxiliary converter is based on a semiconductor device, and thus further requires access of control lines. The control lines are accessed through two control line connecting terminals on the side wall of the case 10 at the lower right corner of Fig. 2.

10 In the description of the embodiment, it should be understood that, orientation or position relationships indicated by terms, such as “upper”, “lower”, “bottom”, “top”, “front”, “rear”, “inner”, “outer”, “left”, “right”, are based on orientation or position relationships shown in the drawings. It is merely for ease of describing the present application and simplifying the description, and not for indicating or implying that the device or element referred to needs to have a specific orientation and be constructed
15 and operated in the specific orientation, and thus it cannot be interpreted as a limitation on the present application.

Although the present application is described herein with reference to specific implementations, it should be understood that these embodiments are merely examples of principles and applications of the present application. Therefore, it should
20 be understood that many modifications may be made to the exemplary embodiments and other arrangements may be devised as long as they do not depart from the spirit and scope of the present application as defined by the appended claims. It should be understood that different dependent claims and features described herein may be combined in ways different from those described in the original claims. It may also be
25 understood that features described in conjunction with separate embodiments may be used in the other embodiments.

Claims

5 1. An integrated auxiliary converter with high power density, characterized in that the integrated auxiliary converter comprises two converter modules disposed in a same case, a plurality of functional modules in each converter module are overall of a linear layout structure distributed in one direction, and the two converter modules are overall laid out in the case in a mirrored manner; and

10 the functional modules corresponding to an input end and an output end of a circuit structure of each converter module are located at two ends of the corresponding linear layout structure respectively, and side walls of two opposite sides of the case corresponding to the two ends of each linear layout structure are provided with an input line connecting structure and an output line connecting structure respectively.

15 2. The integrated auxiliary converter with high power density according to claim 1, characterized in that lines at the input ends and/or the output ends of the two converter modules are arranged in the case in parallel and then connected to the corresponding line connecting structures.

20 3. The integrated auxiliary converter with high power density according to claim 2, characterized in that the output end of each converter module is provided with a direct-current output portion and an alternating-current output portion, and direct-current output portions and alternating-current output portions of the two converter modules are respectively connected in the case in parallel and then output

25 through the corresponding output line connecting structures.

 4. The integrated auxiliary converter with high power density according to claim 3, characterized in that the output line connecting structures respectively corresponding to the direct-current output portions and the alternating-current output portions are located at two ends on a side wall of a same side of the case.

30 5. The integrated auxiliary converter with high power density according to claim 1, characterized in that an interior of the case is divided into two mounting areas for mounting the converter modules, each mounting area is sequentially separated into a relatively independent first assembly region, second assembly region and third assembly region in a direction of the corresponding linear layout structure, so as to

mount the corresponding functional modules respectively.

6. The integrated auxiliary converter with high power density according to claim 5, characterized in that each mounting area is internally provided with a heat-dissipating duct, the heat-dissipating duct is provided with an air inlet and air outlets, the air inlet corresponds to the second assembly region, and the air outlets are provided at a bottom of the case corresponding to the first assembly region and the third assembly region respectively;

wherein cooling air input through the air inlet passes through the second assembly region, then enters the first assembly region and third assembly region respectively, and is output through the corresponding air outlets.

7. The integrated auxiliary converter with high power density according to claim 6, characterized in that the two mounting areas are spaced by a certain distance, and corresponding assembly regions of the two mounting areas correspond to independent air outlets respectively; or the two mounting areas are adjacent, and two corresponding adjacent assembly regions of the two mounting areas share one of the air outlets.

8. The integrated auxiliary converter with high power density according to claim 6 or 7, characterized in that two heat-dissipating ducts corresponding to the two mounting areas are provided with fans respectively, and the fans are disposed in the second assembly regions;

or the two heat-dissipating ducts corresponding to the two mounting areas share one fan, the two second assembly regions of the two mounting areas communicate with each other, and the fan is disposed at an intersection of the two second assembly regions.

9. The integrated auxiliary converter with high power density according to claim 8, characterized in that in a case that the two heat-dissipating ducts are provided with the fans respectively, each fan is embedded in the corresponding air inlet, or each fan directly faces the corresponding air inlet and is at a certain distance from the corresponding air inlet.

10. The integrated auxiliary converter with high power density according to claim 6 or 7, characterized in that each of the first assembly regions and the third assembly regions is separated into a first assembly cavity and a second assembly cavity that are relatively independent, and the air outlets correspond to the second assembly cavities; and the first assembly cavities and the second assembly cavities

communicate with the second assembly regions respectively through the air inlets corresponding thereto, and the first assembly cavities and the second assembly cavities communicate with each other through ventilation openings at ends away from the air inlets.

5 11. The integrated auxiliary converter with high power density according to claim 10, characterized in that the air inlets corresponding to the first assembly cavities have a circulation area greater than that of the air inlets corresponding to the second assembly cavities.

10 12. The integrated auxiliary converter with high power density according to claim 6 or 7, characterized in that a middle partition plate is disposed between the two mounting areas in the case; and the middle partition plate overall isolates the first to third assembly regions of the two mounting areas, or the middle partition plate only isolates the two second assembly regions of the two mounting areas.

15 13. The integrated auxiliary converter with high power density according to claim 6 or 7, characterized in that filtering devices are disposed at the air inlets, and provided with dust discharge outlets to discharge filtered and accumulated dust.

20 14. The integrated auxiliary converter with high power density according to any one of claims 1 to 7, characterized in that the case has a rectangular shape, a width of the case in a first direction is adapted to a width of a corresponding train body, and edges of two sides of the case in the first direction are further provided with lifting lugs for being connected to side-face beams of the train body; and the first direction is perpendicular to a direction from one of the converter modules to the other converter module.