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(54) **MODULAR ELECTRONIC ENCLOSURE**

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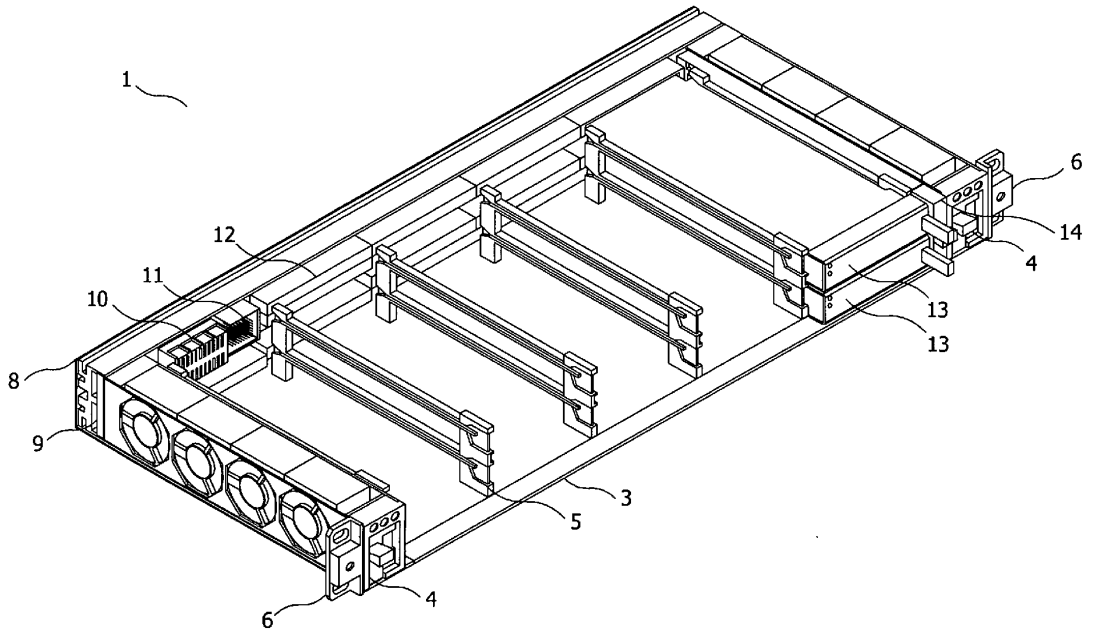
(57) **ABSTRACT**

A modular electronic enclosure having a maximum height of 1 U and a width adapted to fit between the rails of a 19 inch rack is adapted to receive up to ten single-width Advanced Mezzanine Cards (AMCs) installed horizontally in the enclosure. Some modules that are not compliant with AMC standards may be installed in the modular electronic enclosure. A backplane, backplane structural support, combined card guide, chassis cover, and chassis bottom cooperate mechanically to provide a stiff, stable enclosure resistant to mechanical flexure. The modular electronic enclosure includes two hot-swappable cooling units which cooperate to establish push-pull cooling airflow. The modular electronic enclosure is further adapted to receive a Power Unit and an MCH. In another embodiment, the modular electronic enclosure includes a backplane with more than one core and has mounting locations and electrical connectors for up to twenty single-width 4 HP electronic modules. A backplane having more than one core is included in some embodiments. In some embodiments, the modular electronic enclosure is adapted to receive a combination of electronic modules comprising single-width, dual-width, and quad-width electronic modules. Some embodiments optionally include an MCH, a power unit module, or a J-TAG Switch module, or combinations of these and other modules.



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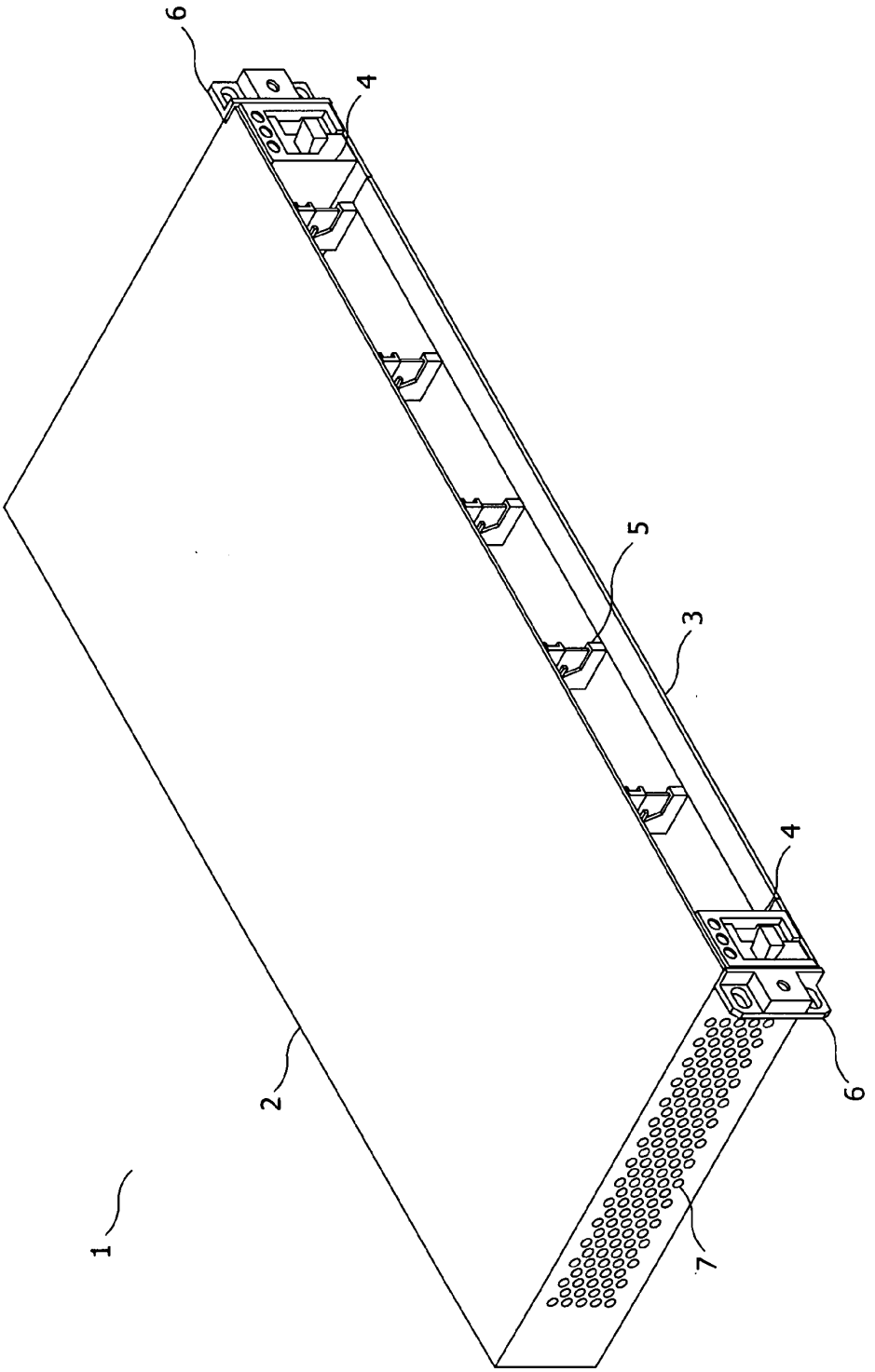

Fig. 1

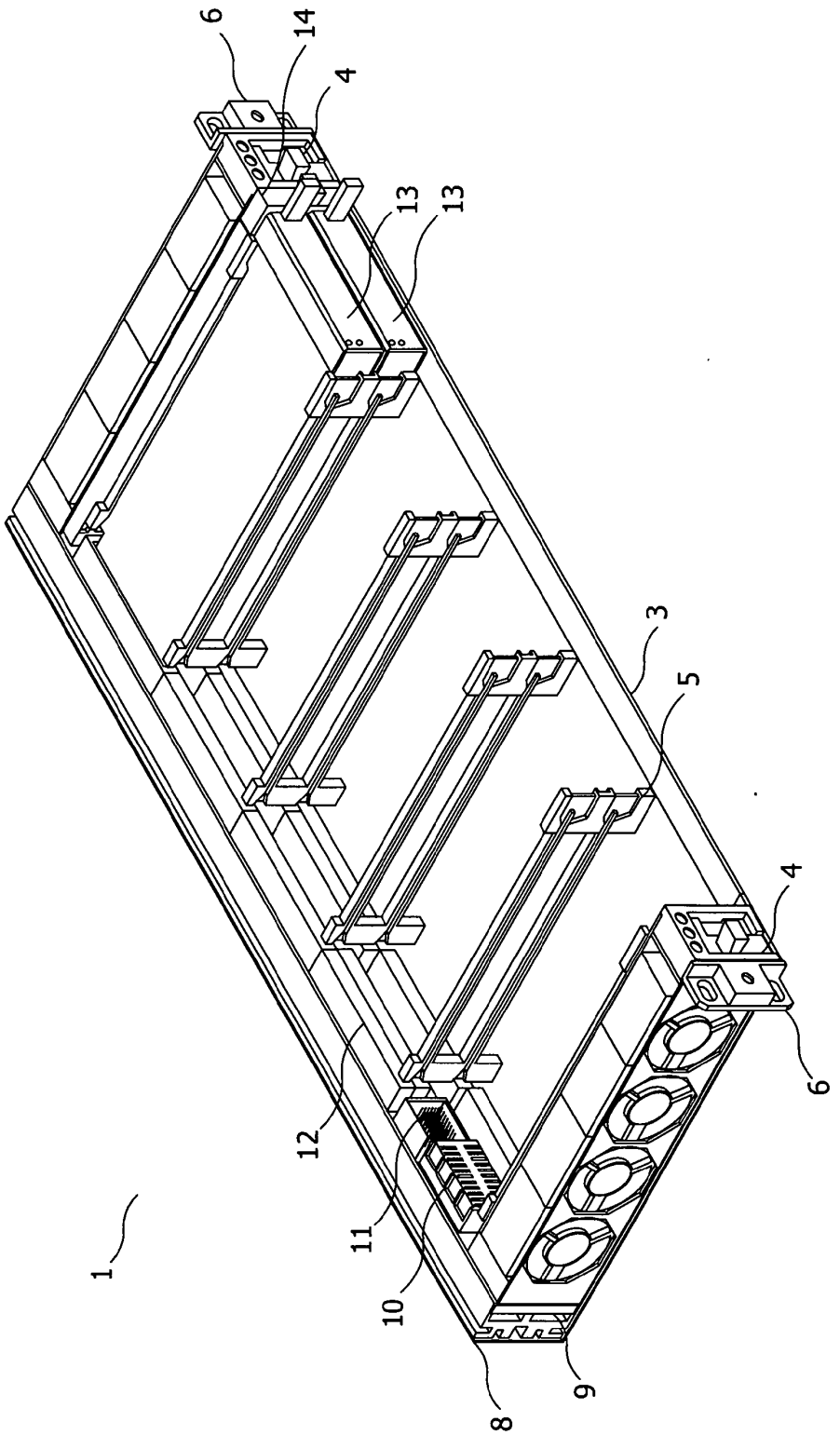

Fig. 2

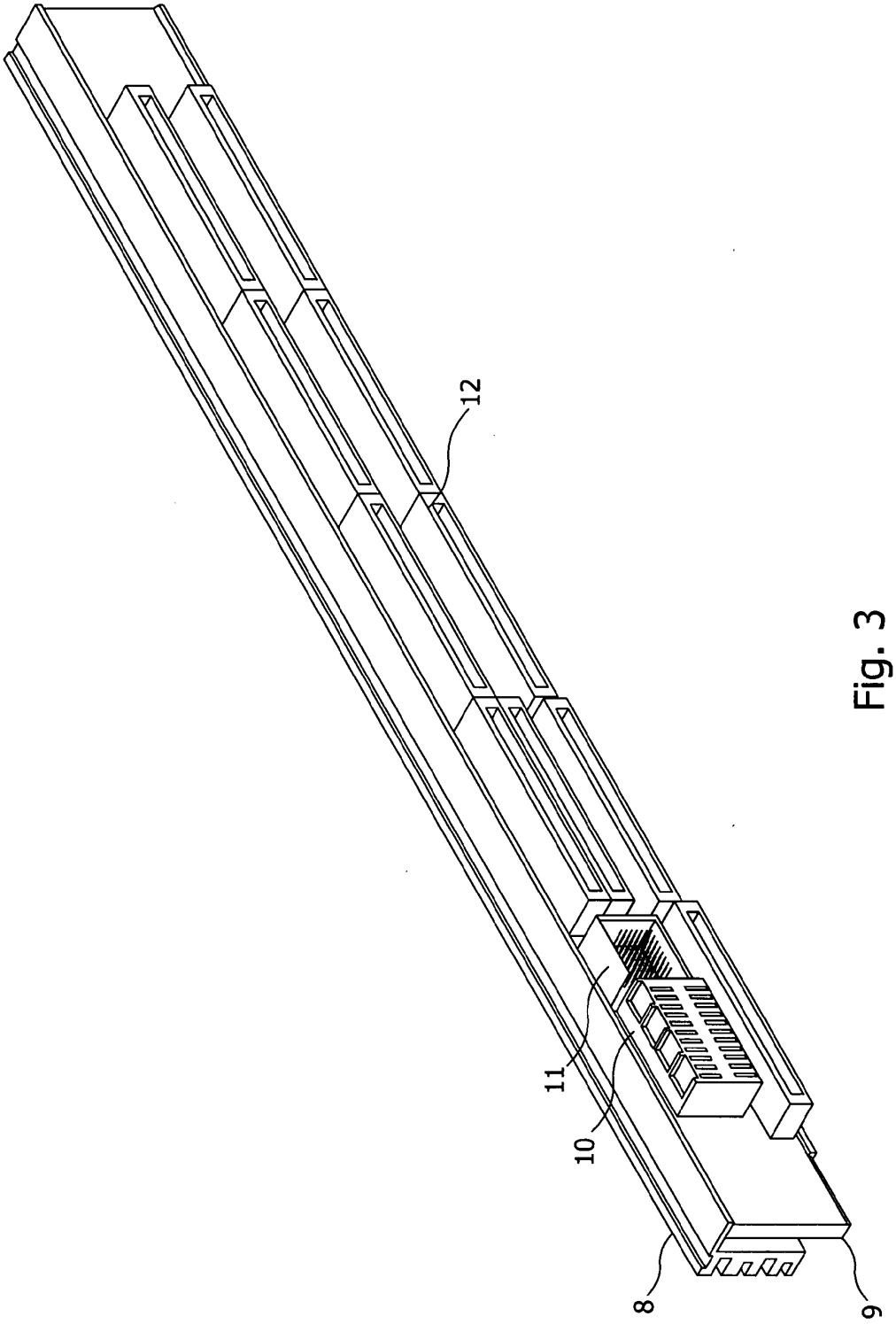

Fig. 3

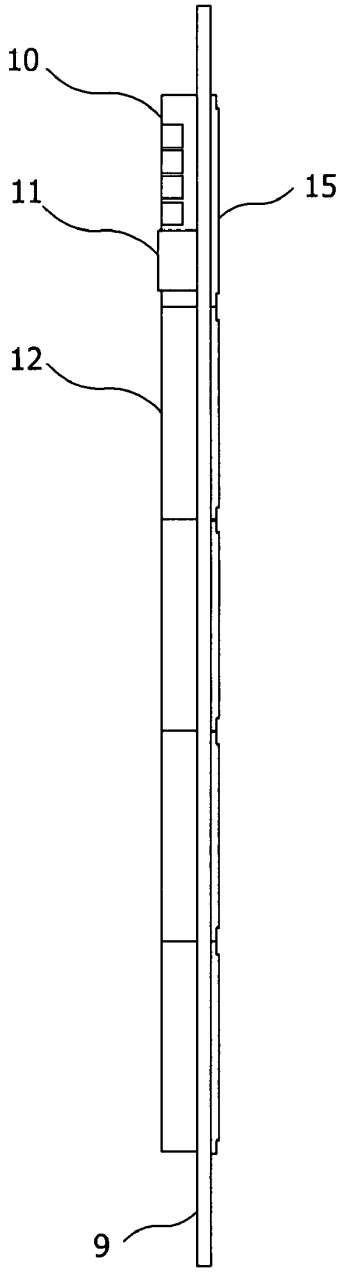

Fig. 4

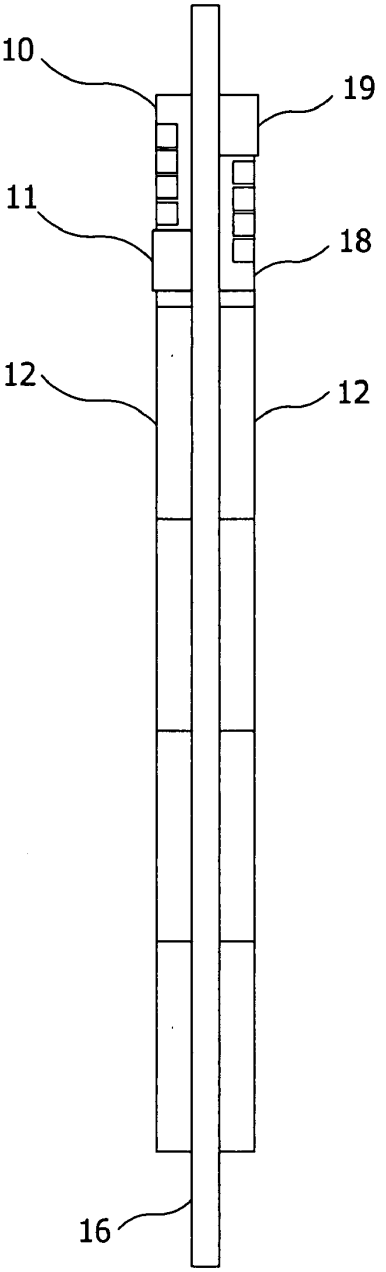

Fig. 5

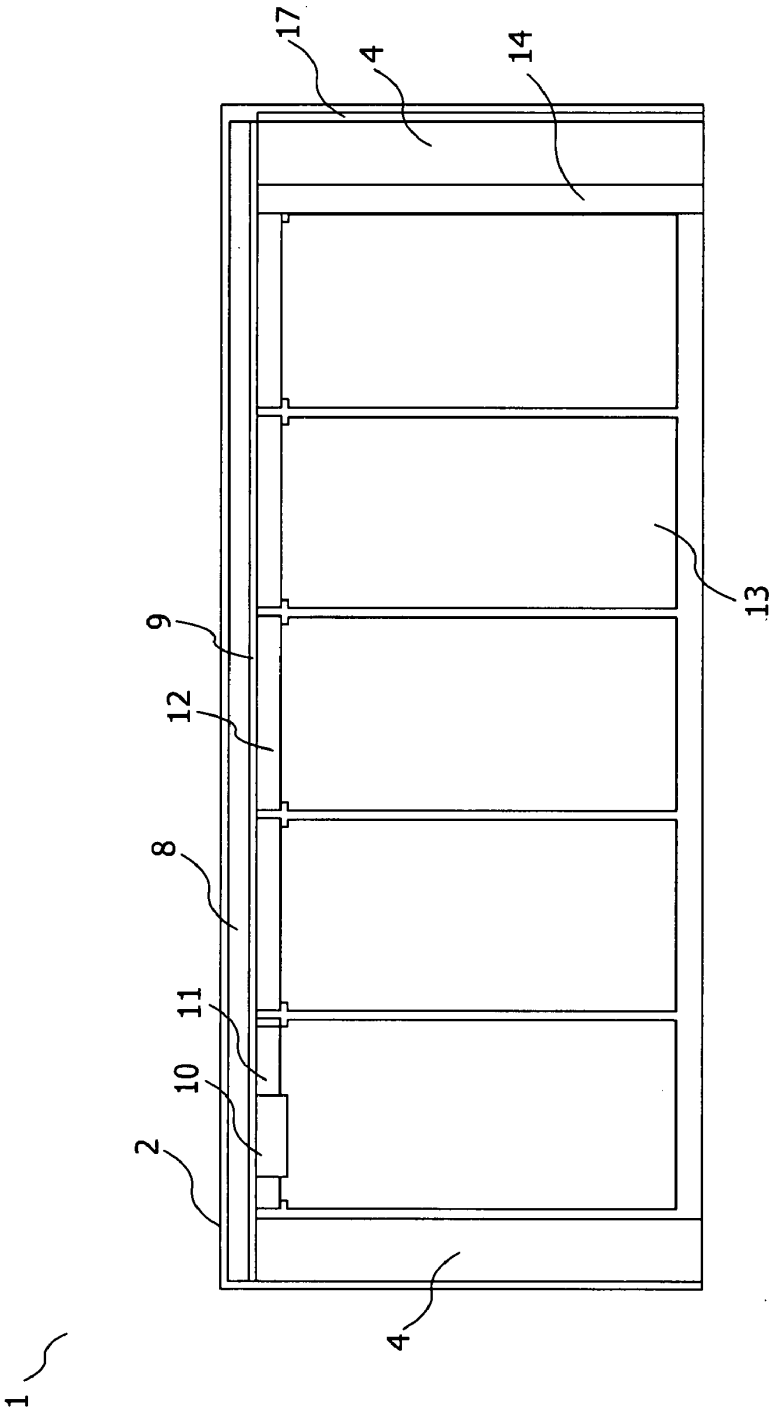

Fig. 6

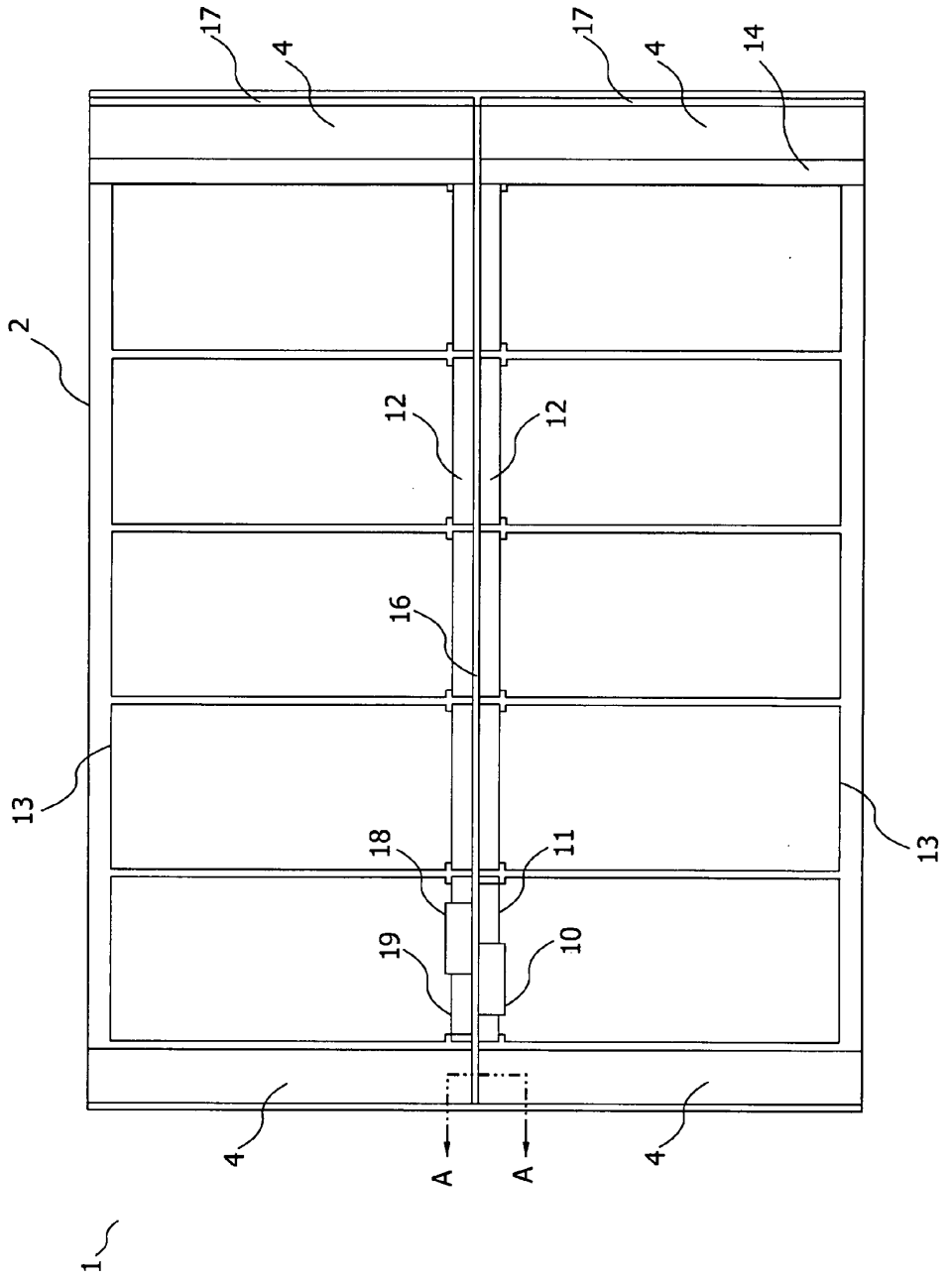

Fig. 7

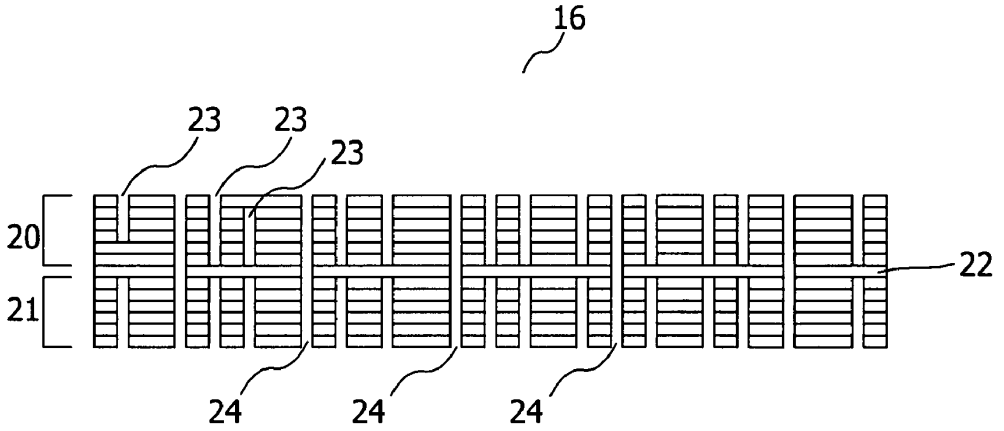

Fig. 8

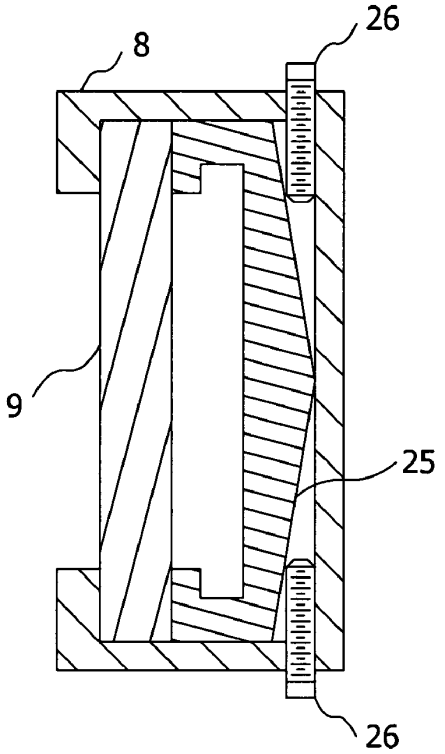

Fig. 9

MODULAR ELECTRONIC ENCLOSURE

FIELD OF THE INVENTION

[0001] The present disclosure relates generally to computer and telecommunications equipment and more specifically to a modular electronic enclosure adapted for operation of Advanced Mezzanine Cards.

BACKGROUND

[0002] Manufacturers and users of telecommunications equipment, networking equipment, computer systems, and other types of electronic systems comprising computing and communications functions have proposed several non-proprietary standards to reduce costs, reduce time to market, and improve performance. The dissemination and use of such non-proprietary standards, also known as open architecture standards, is believed to improve interoperability and increase reliability in products compliant with those standards. Open architecture standards for telecommunications and computing equipment may include, for example, mechanical dimensions of enclosures, racks, and electronic modules, power dissipation limits, and thermal management schemes. Open architecture standards may also include definitions of communications and control signals to be exchanged between functional elements inside a system and between the system and the outside world, electrical connector styles and pin assignments, operating voltages and currents, software commands, and data formats.

[0003] Some examples of open architecture standards for telecommunications, networking, and computer equipment include Advanced Telecommunications Computing Architecture, Advanced Mezzanine Card, and Micro Telecommunications Computing Architecture. Advanced Telecommunictions Computing Architecture, also known as ATCA and AdvancedTCA, comprises an open architecture for high-performance, high-reliability telecommunications modules. More than one AdvancedTCA module may be mechanically and electrically connected to an enclosure known in the art as a telecom shelf. A telecom shelf may have an open-frame chassis or be partially or fully enclosed. Each telecom shelf is further adapted for attachment to an equipment rack. Equipment racks having a width of 19 inches (482.6 mm) are most common, but racks with other widths are also used. More than one telecom shelf may be connected to a rack, and the rack may further be located inside a cabinet to aid in thermal management, provide electrical shielding, and provide mechanical protection. A large system may comprise more than one rack, cabinet, or a combination of racks and cabinets.

[0004] A height measurement for an AdvancedTCA module is 14.0 inches (355.6 mm), known in the art as a height of 8 U. The 8 U designation is in reference to widely recognized conventions for describing a panel height for rack-mounted equipment, wherein a height increment of 1 U corresponds to 1.75 inches (44.5 mm). The relatively large size of an AdvancedTCA module enables many complex functions to be incorporated into a single module, making AdvancedTCA an attractive solution for large, high performance systems.

[0005] One type of AdvancedTCA module is a carrier board, also known as an ATCA carrier. An ATCA carrier couples functional modules to AdvancedTCA infrastructure services such as power, ground, timing signals, data and command buses, status signals, error signals, and other input and output signals. A type of functional module designed to operate with an ATCA carrier is known as an Advanced Mezzanine Card. Advanced Mezzanine Cards, also referred to as AdvancedMCs or AMCs, comply with mechanical, electrical, power, software, and other requirements in the AdvancedTCA standard.

[0006] Up to eight AdvancedMCs may be connected to an ATCA carrier. An AdvancedMC may be connected to or disconnected from an ATCA carrier without turning off power to other modules on the carrier, a feature known in the art as hot-swapping. Hot-swapping enables maintenance to be performed on one AdvancedMC without removing other AdvancedMCs from service. AdvancedMCs help improve the overall reliability of an ATCA system because a failure in a single module will not cause the entire system to fail. Furthermore, uninterrupted system availability, a measure of system reliability, may be increased by installing as many redundant AdvancedMCs as are needed to have a desired confidence level that a preferred minimum number of AdvancedMCs is always in operation. Also, by adding or removing AdvancedMCs from a system, performance attributes such as storage capacity or rate of data transfer may be readily scaled up or down to address changes in application requirements.

[0007] While AdvancedTCA telecom shelves are well-suited for many large-scale applications, they may be too large and expensive for some applications. Another open architecture standard called Micro Telecommunications Computing Architecture, also known as MicroTCA, connects the same types of AdvancedMCs compatible with AdvancedTCA to a backplane, thereby eliminating ATCA carrier modules and enabling size and cost reductions compared to AdvancedTCA. A first version of a MicroTCA standard was released by the Compact PCI Industrial Computer Manufacturers Group (PICMG) in July 2006.

[0008] A MicroTCA system comprises at least one AdvancedMC, at least one MicroTCA Carrier Hub (MCH), and the interconnect, power, cooling, and mechanical infrastructure to support them. MicroTCA systems may vary in size from small, stand-alone enclosures comprising a small number of AdvancedMCs to installations including multiple telecom shelves with hundreds of cards. MicroTCA systems are well suited to, but are not limited to, applications requiring a smaller enclosure or applications that may operate with a lower reliability target than is generally offered by an ATCA system. Examples of MicroTCA applications include wireless Internet access points, medical instrumentation, industrial monitoring and control, digital imaging, and enterprise applications.

[0009] The MicroTCA standard recommends a height range of 2 U to 6 U (3.5 inches to 10.5 inches) (88.9 mm to 266.7 mm) for a MicroTCA telecom shelf to be mounted in a rack. Modules having a height of about 0.5 inch (14 mm) are referred to as 3 HP or alternatively as half-height. Modules having a height of about 0.7 inch (19 mm) are referred to as 4 HP or alternatively mid-size. Modules having a height of about 1.1 inch (29 mm) are referred to as **6**HP or alternatively full-size. Modules having a width of approximately 2.9 inch (74 mm) are referred to as single-width. A module with about twice the width of a single module is referred to as having double-width and one with about four times the width of a single module is referred to as having quad-width. Full-size, mid-size, and half-height modules may alternatively be made with single-width, double-width, or quad-width.

[0010] Previously, the smallest rack-mountable MicroTCA enclosure had a height of 2 U and was limited to two 6 HP AdvancedMCs. An enclosure having a height of approximately 1 U is also known in the art, but it is not rack-mountable and is limited to two **6**HP AdvancedMCs. For applications needing more than two AdvancedMCs in a rack-mountable enclosure, the solution was to use a relatively large enclosure, thereby increasing the size and cost of the finished system. Furthermore, reductions in the size of structural elements, backplanes, connectors, and other components used in enclosures having a height of 2 U or more was expected to result in rack-mountable enclosures smaller than 2 U having insufficient mechanical strength, thereby leading to reduced reliability. What is needed is a MicroTCA enclosure system that can be mounted in a 19 inch rack, holds up to ten single-width 4 HP electronic modules having a size comparable to AMCs in an enclosure having a height of 1 U, is able to operate with some electronic modules that are not fully compliant with AdvancedMC standards, and includes all necessary infrastructure for power, cooling, monitoring, and input/output, and giving adequate mechanical support to all components.

SUMMARY

[0011] In one embodiment, a modular electronic enclosure has a height of 1 U. The modular electronic enclosure has a width and mounting features adapted for attachment to a 19 inch rack and has a depth adapted to contain a 4 HP single-width electronic module having a size comparable to an AdvancedMC. The modular electronic enclosure comprises a rear surface comprising a backplane structural support, a chassis cover connected to a top surface of the backplane structural support, and a chassis bottom connected to a bottom surface of the backplane structural support. The chassis cover is formed into an enclosure top, an enclosure right side, and an enclosure left side, wherein the enclosure right side and enclosure left side are parallel to each other and at right angles to the enclosure top. A plurality of perforations formed in the chassis cover right side and the chassis cover left side enable air to flow into and out of the interior of the modular electronic enclosure.

[0012] In some embodiments, a backplane is attached to an inner surface of the backplane structural support. A sufficient number of connectors are installed on a large surface of the backplane facing the interior of the enclosure to enable connection of up to ten single-width AMCs. Optionally, some electronic modules which are not fully compliant with AdvancedMC specifications may be installed in the modular electronic enclosure and may be connected to the backplane, for example, an electronic module which is a power unit or an electronic module which is a J-TAG switch module. The backplane also provides hot-swappable electrical connections to a first cooling unit near one end of the backplane and a second cooling unit near an opposite end of the backplane. The backplane further provides electrical and mechanical connections for an MCH. In some embodiments, some connectors attached to the backplane are compression-type connectors.

[0013] A plurality of combined card guides is provided to align connectors on mid-size AdvancedMCs with corresponding connectors on the backplane. A combined card guide has a height adapted to fit between an inner surface of the chassis cover and an inner surface of the chassis bottom and is formed with two parallel channels along a length of the guide to provide support for two AdvancedMCs or similar electronic modules, one above the other. In some embodiments, a combined card guide has one channel and provides support for a single electronic module. Support surfaces along a top edge and a bottom edge of a combined card guide are connected to the chassis cover and chassis bottom with threaded fasteners. The combination comprising the chassis cover, chassis bottom, backplane structural support, and combined card guides cooperate to provide a stiff, stable mechanical structure. In other embodiments, a number and location of single-channel and two-channel combined card guides are selected to enable installation of double-width AdvancedMCs or similar electronic modules. In other embodiments, a number and location of single-channel and two-channel combined card guides are selected to enable installation of quad-width electronic modules.

[0014] The first and second cooling units are adapted for hot-swapping and cooperate in a push-pull cooling arrangement to cool the interior of the modular electronic enclosure. At least one filter is provided adjacent to a cooling unit to remove large particles entrained in air flowing into the enclosure. A cooling unit comprises four axial-flow fans mounted side by side in a tray connected to a front panel having a handle and lighted cooling unit status indicators.

[0015] In another embodiment, a multiple-core backplane is adapted for connection of up to ten AdvancedMCs on each side of the backplane. The multiple-core backplane has a thickness chosen to provide a sufficient number of layers for the number of interconnections to be made. Additional combined card guides are coupled to the backplane, the chassis cover, and the chassis bottom to enable AdvancedMCs to enter the enclosure from the front or the back, thereby providing connections and mounting locations for up to twenty 4 HP single-width AdvancedMCs in a 1 U modular electronic enclosure. In other embodiments, a backplane may have more than two cores.

[0016] This section summarizes some features of the present embodiment. These and other features, aspects, and advantages of the embodiments of the invention will become better understood with regard to the following description and upon reference to the following drawings, wherein:

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] FIG. **1** is an isometric view of the front, top, and left side of a modular electronic enclosure having a height of 1 U.

[0018] FIG. **2** is an isometric view of the enclosure of FIG. **1** with the chassis cover removed and further showing an example installation of two 4 HP AdvancedMCs and an MCH.

[0019] FIG. **3** is an isometric view of a backplane and backplane structural support for the embodiment of FIG. **1**.

[0020] FIG. **4** is top view (rotated 90 degrees) of the backplane of FIG. **3**.

[0021] FIG. **5** is a top view of an example of a backplane having more than one core.

[0022] FIG. **6** is a simplified top view of the embodiment of FIG. **1**, showing a row of five electronic modules installed in the modular electronic enclosure.

[0023] FIG. **7** is a simplified top view of an embodiment of a modular electronic enclosure having a multiple-core back plane and showing two rows of five electronic modules installed in the enclosure.

[0024] FIG. **8** is a partial enlarged sectional view of an example of a backplane having two cores. The viewing direction for FIG. **8** is shown by the line marked A-A in FIG. **7**.

[0025] FIG. **9** is a partial sectional view of an embodiment of a backplane structural support.

DESCRIPTION

[0026] Embodiments of the invention include a modular electronic enclosure having a height of 1 U and adapted to operate with electronic modules having a size, an electrical interface, and a power requirement compatible with an AdvancedMC. Some electronic modules that are not compatible with AdvancedMC standards may optionally be installed in the modular electronic enclosure. In an embodiment shown in FIG. **1**, a modular electronic enclosure **1** comprises a chassis cover **2**, a chassis bottom **3**, two cooling units **4**, six combined card guides **5**, and a pair of rack mounting flanges **6**. An open side of the modular electronic enclosure **1** through which several card guides **5** are visible is referred to herein as the front of the enclosure. The modular electronic enclosure **1** has a width adapted to fit between the rails of a 19-inch (482.6 mm) rack. Two rack mounting flanges **6**, one on either side of the chassis, enable attachment of the modular electronic enclosure **1** to the rails of a rack. In other embodiments, the modular electronic enclosure **1** has a width adapted to fit other rack sizes. The modular electronic enclosure **1** has a depth adapted to contain a 4 HP single-height AdvancedMC, a backplane, and related mechanical elements. In one embodiment, the modular electronic enclosure has a depth of 7.87 inches (200 mm).

[0027] The chassis cover **2** is formed into an enclosure top, an enclosure right side, and an enclosure left side, wherein the enclosure right side and enclosure left side are parallel to each other and at right angles to the enclosure top. A plurality of perforations formed in the chassis cover right side and the chassis cover left side enable air to flow into and out of the interior of the modular electronic enclosure **1**. A first mounting bracket **6** connected to the enclosure left side near the front of the enclosure and a second mounting bracket **6** connected to the enclosure right side near the front enable attachment of the modular electronic enclosure **1** to the rails of an equipment rack.

[0028] The embodiment of FIG. **1** is shown with the chassis cover **2** removed in FIG. **2**, thereby exposing components located in the interior of the enclosure. A cooling unit **4** comprises four axial-flow fans and a front panel coupled to a metal tray that slides into the enclosure **1**. The cooling unit **4** is adapted to be hot-swappable. In other embodiments, a different number and type of fans may be used. The front panel of the cooling unit **4** includes lighted indicators to visually indicate the operating status of the cooling unit **4**. A handle on the front panel of the cooling unit **4** is connected to a latching mechanism inside the cooling unit that helps retain the cooling unit **4** into the enclosure **1**. The cooling unit is connected at a back surface to a backplane **9**. Power is supplied to the cooling unit and status and monitoring signals pass between the cooling unit and an MCH **14**, through the backplane **9** connection.

[0029] The combined card guides **5**, six of which are shown in FIG. **2**, provide structural support to the modular electronic enclosure **1** and facilitate proper alignment and retention of AdvancedMCs installed in the enclosure. Some combined card guides **5** have one mounting channel for an electronic module and some card guides **5** have two parallel mounting channels for two electronic modules, coupled to the combined card guide **5** one above another with a sliding fit in the mounting channel. The combined card guides **5** are attached to the chassis bottom **3** with threaded fasteners. The combined card guides **5** are also connected to the chassis cover **2** with threaded fasteners when the chassis cover **2** is in place. A distance separating two adjacent combined card guides **5** is chosen to enable a single-width AdvancedMC or an electronic module having a similar size to fit between the card guides **5** and couple with a sliding fit into channels formed in the card guides **5**. In other embodiments, a number and location of single-channel and two-channel combined card guides **5** are selected to enable installation of double-width electronic modules. In other embodiments, a number and location of single-channel and two-channel combined card guides are selected to enable installation of quad-width electronic modules or alternatively, combinations of single-width, double-width, and quad-width electronic modules. The combined card guides **5** are further positioned so as to align electrical connectors included as part of an electronic module to be installed in the modular electronic enclosure with corresponding electrical connectors (**10**, **11**, **12**) attached to a surface of a backplane **9**. A card guide **5** also includes attachment points to which a latching mechanism included with an electronic module connects when the electronic module is installed in the modular electronic enclosure **1**.

[0030] An example of an MCH **14** installed in the modular electronic enclosure **1** is shown in FIG. **2**. The MCH **14** is adjacent to a cooling unit **14** near the right side of the modular electronic enclosure **1**. The MCH **14** is connected to the backplane **9** and exchanges control, data, and status signals with other parts of the modular electronic enclosure **1**, with other electronic modules installed in the enclosure **1**, and with external systems.

[0031] An example installation of electronic modules is shown in FIG. **2**. Two electronic modules **13** having a size comparable to a 4 HP single-width AMC are coupled to combined card guides **5** near the right side of the modular electronic enclosure **1**. A bar protruding from a face plate on an electronic module **13** in FIG. **2** represents an ejection and latching mechanism that couples an electronic module **13** to a combined card guide **5** and disconnects electronic module **13** from the backplane **9** when removal of the electronic module **13** from the enclosure is desired. As can be seen in FIG. **2**, positions for up to ten single-width 4 HP electronic modules are provided in the enclosure embodiment described.

[0032] A back surface of the modular electronic enclosure embodiment of FIG. **1** and FIG. **2** comprises a backplane structural support **8**. The backplane structural support **8** is also shown in FIG. **3**. In the illustrated embodiment, the backplane structural support **8** is formed from extruded aluminum alloy. In other embodiments, the backplane structural support **8** is formed from machined or bent steel alloy or aluminum alloy. The backplane structural support **8** is formed with apertures and channels to engage with mechanical fasteners used to connect the backplane structural support **8** to the backplane **9**, the chassis bottom **3**, the chassis cover **2** (shown in FIG. **1**), and support brackets for the cooling units **4**. The backplane structural support **8** cooperates with the chassis cover **2**, chassis bottom **3**, combined card guides **5**, and support brackets for the cooling units **4** to form a stiff, stable mechanical structure for the modular electronic enclosure **1**.

[0033] In some embodiments, the backplane structural support includes an adjustable element to provide firm mounting of backplanes that may have variations in a thickness dimension. Such variation may occur, for example, when the number of layers in a backplane is changed. FIG. **9** illustrates a cross-sectional view of a backplane structural support **8** having a movable backplane clamp **25** in contact with a surface of a backplane **9** and a surface of the backplane structural support **8**. A plurality of threaded fasteners **26** passing through threaded holes formed in the backplane structural support **8** apply an adjustable amount of pressure to an angled surface of the backplane clamp **25**, thereby moving the backplane clamp **25** until it comes into contact with a surface of the backplane **9** and holding the backplane **9** firmly against the backplane structural support **8**. This configuration has the advantage of providing a fixed positional reference for an outer surface of the backplane **9**, that is, a surface of the backplane **9** upon which connectors are attached, where such positional reference is not dependent on a thickness dimension of the backplane **9**.

[0034] Power and other electrical signals pass between components in the modular electronic enclosure **1** through the backplane **9**. Timing, data, command, status, and other signals also pass between electronic modules and an MCH installed in the enclosure through the backplane **9**. The backplane **9** is shown attached to the backplane structural support **8** in FIG. **2** and FIG. **3**. A top view of the backplane **9** and backplane structural support **8** from FIG. **3** is shown in FIG. **4**. Connectors attached to the backplane **9** enable connection of up to ten single-width 4 HP electronic modules. A first power connector **10** and a second power connector **11** located near an end of the backplane **9** are provided for connection of an AdvancedMC Power Unit. In a location adjacent to the power connector **12**, two mating connectors for an edge connector **12** are attached to the backplane **9**, one immediately above the other. In other locations, a single mating connector for an edge connector **12** is provided for connection to an electronic module. In the embodiment shown in FIG. **4**, a connector backing plate **15** is installed behind each connector on the backplane **9** to provide additional stiffness to the backplane **9**. In other embodiments, the connector backing plate **15** may be omitted.

[0035] In the embodiment shown in FIG. **2**, FIG. **3**, and FIG. **4**, the first power connector **10** and the second power connector **11** are shown as separate connectors. In other embodiments, the functions of the first power connector **10** and the second power connector **11** are combined into a single connector. Also, in other embodiments the order and arrangement of power connectors (**10**, **11**), mating connectors for an edge connector **12**, and connectors for MCH **14** and cooling units **4** are changed to provide for a different arrangement of AdvancedMCs, electronic modules, MCH, and cooling units. In some embodiments, some of the connectors are compression-type connectors.

[0036] A simplified top view of the embodiment of FIG. **1** is shown in FIG. **6**. FIG. **6** illustrates five single-width electronic modules **13** next to each other inside the modular electronic enclosure **1**. A second row of five electronic modules may be installed below the row visible in the figure. The relative positions of the chassis cover **2**, backplane support **8**, backplane **9**, cooling units **4**, power connectors (**10**, **11**), mating connectors for an edge connector **12**, and MCH **14** are also indicated. A position for an air filter **17** is shown next to a cooling unit **4**. The air filter **17** prevents large solid particles entrained in air from being drawn into the enclosure.

[0037] In an alternate embodiment, a length of the modular enclosure **1** is increased to enable the enclosure to contain up to twenty single-width 4 HP electronic modules. A simplified top view of the alternate embodiment is shown in FIG. **7**. In comparison to the embodiment of FIG. **6**, the embodiment of FIG. **7** has a multiple-core backplane **16** having at least two cores and electronic modules **13** may be installed from both the front and back sides of the modular electronic enclosure **1**. In the embodiment shown in FIG. **7**, a first set of power connectors (**10**, **11**), mating connectors for an edge connector **12**, and other connectors are installed on a first side of a multiple-core backplane **16**. A second set of power connectors (**18**, **19**) and mating connectors for an edge connector **12** are installed on a second side of multiple-core backplane **16**. The multiple-core backplane **16** has a thickness chosen to provide a sufficient number of layers for the number of interconnections to be made. In an alternate embodiment, the third power connector **18** and the fourth power connector **19** are replaced by mating connectors for an edge connector **12**, thereby removing a position for a second Power Unit and increasing capacity for other types of AdvancedMCs. In other embodiments, the order and arrangement of power connectors and mating connectors for an edge connector is changed to permit other arrangements of AdvancedMCs, electronic modules, cooling units, and MCH.

[0038] An enlarged sectional view of the multiple-core backplane **16** from FIG. **7** is shown in FIG. **8**. FIG. **8** shows an example of the layers and vias comprising a multilayer printed circuit board having two cores. Some layers are insulating layers and some layers contain electrical conductors. The multilayer printed circuit board is divided into two portions, a first core **20** and a second core **21**, separated by an insulating layer **22**. In other embodiments, the multiple-core backplane **16** may have more than two cores.

[0039] Electrical connections are made between electrical conductors on separate layers by metallic-plated holes called vias. As shown in the example of FIG. **8**, some vias **24** penetrate all layers of the printed circuit board and are selectively connected to individual layers by joining the metallic plating in the via to a metallic electrical conductor in the circuit layer. Other vias, known as blind vias **23**, do not penetrate all layers of the printed circuit board. Blind vias **23** may be selectively connected electrically to individual layers. A multiple-core backplane **16** requires the use of both regular vias **24** and blind vias **23** to form electrical connections between passive and active components and connectors on both sides of the backplane.

[0040] The present disclosure is to be taken as illustrative rather than as limiting the scope, nature, or spirit of the subject matter claimed below. Numerous modifications and variations will become apparent to those skilled in the art after studying the disclosure, including use of equivalent functional and/or structural substitutes for elements described herein, use of equivalent functional couplings for couplings described herein, or use of equivalent functional steps for steps described herein. Such insubstantial variations are to be considered within the scope of what is contemplated here. Moreover, if plural examples are given for specific means, or steps, and extrapolation between or beyond such given examples is obvious in view of the present disclosure, then the disclosure is to be deemed as effectively disclosing and thus covering at least such extrapolations.

[0041] Unless expressly stated otherwise herein, ordinary terms have their corresponding ordinary meanings within the respective contexts of their presentations, and ordinary terms of art have their corresponding regular meanings.

What is claimed is:

1. A modular electronic enclosure, comprising:

a chassis, wherein said chassis is adapted for attachment to a nineteen-inch equipment rack;

a backplane comprising a first surface and a second surface, wherein said backplane is attached to said chassis, said backplane and said chassis are adapted to receive a first and a second mid-size single-width electronic module in a horizontal orientation with said first electronic module positioned above said second electronic module, said first and second electronic modules are AdvancedMCs; and

a maximum height dimension of 1 U.

2. The modular electronic enclosure as in claim **1**, further comprising:

a chassis cover, wherein said chassis cover is removably attached to a top side of said chassis;

a chassis bottom, wherein said chassis bottom is removably attached to a bottom side of said chassis;

a first cooling unit, wherein said first cooling unit is removably attached to said chassis bottom and to said backplane; and

a second cooling unit, wherein said second cooling unit is removably attached to said chassis bottom and to said backplane, said first cooling unit is hot-swappable, and said second cooling unit is hot-swappable.

3. The modular electronic enclosure as in claim **2**, further comprising:

a backplane structural support, said backplane structural support further comprising

a backplane clamp, wherein said backplane clamp is adapted for a slidable fit in an aperture formed along a long axis of said backplane structural support, a surface of said backplane clamp contacts a surface of said backplane, an adjustment of said backplane clamp adjusts a position of said backplane; and

a combined card guide comprising a vertical support, an upper support surface on a top edge of said vertical support, a lower support surface on a bottom edge of said vertical support, a first horizontal card support channel formed in said vertical support, and a second horizontal card support channel formed in said vertical support, wherein a height of said combined support guide corresponds to a vertical separation distance between a surface of said chassis cover and a surface of said chassis bottom, a width of said first horizontal card channel and said second horizontal card support channel is adapted for a sliding fit of an AMC, a vertical separation distance between said first horizontal card channel and said second horizontal card channel is adapted to a preferred separation distance for two single-height electronic modules, said combined card guide upper support surface is removably attached to said chassis cover, and said combined card guide lower support surface is removably attached to said chassis bottom.

4. The modular electronic enclosure as in claim **3**, further comprising:

An additional plurality of said combined card guide; and

a plurality of electrical connectors are attached to said second surface of said backplane, wherein said electrical connectors are AdvancedMC-compatible connectors, thereby forming mounting positions for ten single-height electronic modules in two rows of five electronic modules each.

5. The modular electronic enclosure as in claim **4**, further comprising:

a first power connector, said power connector attached to said second surface of said backplane, wherein said power connector is a mating connector for a corresponding connector on a power unit electronic module; and

a plurality of non-AMC electrical connectors attached to said second surface of said backplane, wherein said non-AMC electrical connectors are compatible for connection to electronic modules which are not AMCs.

6. The modular electronic enclosure as in claim **5**, further comprising a second power connector, said second power connector attached to said second surface of said backplane, wherein said second power connector is a mating connector for a corresponding connector on a power unit electronic module.

7. The modular electronic enclosure for as in claim **5**, further comprising a mating connector for a MicroTCA Carrier Hub (MCH), wherein said mating connector for an MCH is attached to said second surface of said backplane.

8. The modular electronic enclosure as in claim **7**, wherein at least two of said combined card guide are separated from each other by a distance adapted to receive a double-width electronic module.

9. The modular electronic enclosure as in claim **8**, wherein at least two of said combined card guide are separated from each other by a distance adapted to receive a quad-width electronic module.

10. The modular electronic enclosure as in claim **7**, wherein said backplane has more than one core.

11. The modular electronic enclosure as in claim **10**, further comprising:

a third cooling unit removably attached to said chassis bottom; and

a fourth cooling unit removably attached to said chassis bottom, wherein said third cooling unit is hot swappable and said fourth cooling unit is hot-swappable.

12. The modular electronic enclosure as in claim **11**, further comprising:

a plurality of additional said combined card guide; and

a plurality of additional electrical connectors attached to said first surface of said backplane, wherein said electrical connectors are mating connectors for corresponding connectors on electronic modules, thereby forming mounting positions for an additional ten single-height electronic modules in two rows of five electronic modules each.

13. The modular electronic enclosure as in claim **12**, wherein at least two of said electrical connectors are joined into one combined electrical connector.

14. The modular electronic enclosure as in claim **13**, wherein at least two of said combined card guide are separated by a distance corresponding to a width of a double-width electronic module.

15. The modular electronic enclosure as in claim **14**, wherein at least two of said combined card guide are separated by a distance corresponding to a width of a quad-width electronic module.

16. The modular electronic enclosure as in claim **7**, further comprising an Advanced Mezzanine Card.

17. The modular electronic enclosure as in claim **16**, further comprising:

an MCH electronic module; and

an MCH plug connector attached to said backplane and connected to said MCH electronic module.

18. The modular electronic enclosure as in claim **17**, further comprising an AMC Power Unit electronic module.

19. The modular electronic enclosure as in claim **18**, further comprising a J-TAG Switch electronic module.

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