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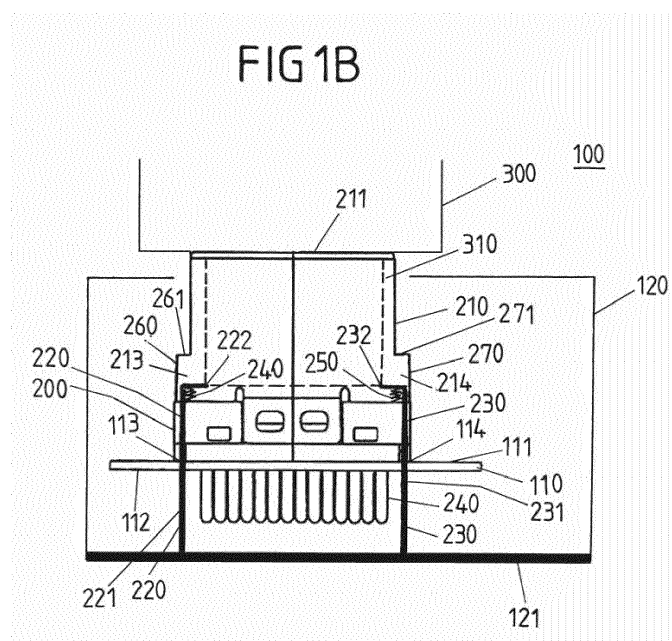
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(54) **GROUNDING OF A CIRCUIT BOARD CONNECTOR**

(57) A circuit board connector (200) configured to be mounted on a circuit board (110) and configured to mate with a cable connector (310) is disclosed. The circuit board connector (200) comprises at least one grounding element (220, 230) transferable from a rest position to a grounding position by mating the cable connector (310) with the circuit board connector (200). Therein, the grounding position is a position for grounding the circuit board connector (200) by means of a direct mechanical contact between the grounding element (220, 230) and

a grounding part (121) distinct from the circuit board (110) and distinct from the circuit board connector (200). Further disclosed is an apparatus (100) comprising such a circuit board connector (200), a circuit board (110) on which the circuit board connector (200) is mounted and a grounding part (121) distinct from the circuit board (110) and distinct from the circuit board connector (200). Also disclosed is a method that involves mounting such a circuit board connector (200) on a circuit board (110).



Description

[0001] The invention relates to grounding a circuit board connector.

[0002] Electromagnetic Compatibility (EMC) is a very important issue in electronic device manufacturing since electronic devices have to satisfy EMC criteria. In many use cases, a multitude of signals is present on circuit boards. Their different frequencies, which may for instance vary from several KHz to several GHz, have to be absorbed by the circuit board in order to prevent unacceptable electromagnetic emissions. Meeting EMC criteria is inter alia rendered difficult by insufficient ground connections. For electronic devices having a circuit board with a circuit board connector configured to mate with a corresponding cable connector mounted thereon, in particular a circuit board connector for a user device, the use of inappropriate or low quality cables may additionally cause undesired emissions.

[0003] A ground connection for a circuit board connector is often established via a conductive path provided on the circuit board, wherein the conductive path is electrically connected to a grounding part having an electric potential defined as ground potential. The grounding part may for instance be a housing part of an apparatus comprising the circuit board. The circuit board connector may have a grounding pin soldered to the conductive path and configured to electrically contact a corresponding grounding pin of the cable connector. The connection from the conductive path on the circuit board to the grounding part may for instance be established by means of a ground electrode. Due to limited circuit board area circuit board grounding paths may be sub-optimal. For instance, a high number of signal paths on the circuit board in an area surrounding the circuit board connector may not allow for optimally routing both circuit board grounding paths and signal paths. Therefore, a ground connection established via a circuit board grounding path might not be continuous and might be weak. Grounding of the circuit board connector is therefore in many cases insufficient, in particular for high frequency signals and when differential signaling is used, which renders meeting EMC criteria difficult.

[0004] It is an object of the present invention to improve circuit board connector grounding.

[0005] According to a first aspect of the present invention, a circuit board connector configured to be mounted on a circuit board and configured to mate with a cable connector is disclosed. The circuit board connector comprises at least one grounding element transferable from a rest position to a grounding position by mating the cable connector with the circuit board connector. Therein, the grounding position is a position for grounding the circuit board connector by means of a direct mechanical contact between the grounding element and a grounding part distinct from the circuit board and distinct from the circuit board connector.

[0006] According to a second aspect of the present

invention, an apparatus is disclosed. The apparatus comprises a circuit board, a circuit board connector according to the first aspect of the present invention mounted on the circuit board and a grounding part distinct from the circuit board and distinct from the circuit board connector. To name but a few non-limiting examples, the apparatus may be a personal computer (PC), a notebook or tablet computer, a server, and entertainment device, e.g. a TV set, a CD player, a DVD player, a blu-ray player or a digital video recorder, or a mobile phone, e.g. a smart phone.

[0007] More than one circuit board connector may be provided on the circuit board of the apparatus according to the second aspect. For instance, several circuit board connectors according to the first aspect of the present invention may be mounted on the circuit board. Alternatively, only a single connector according to the first aspect may be mounted on the circuit board. One or more other circuit board connectors may or may not be additionally provided on the circuit board.

[0008] According to a third aspect of the present invention, a method is disclosed. The method comprises mounting a circuit board connector configured to mate with a cable connector on a circuit board. Therein, the circuit board connector comprises at least one grounding element transferable from a rest position to a grounding position by mating the cable connector with the circuit board connector. The method further comprises arranging the circuit board and a grounding part distinct from the circuit board and distinct from the circuit board connector with respect to each other such that the grounding element is in direct mechanical contact with the grounding part for grounding the circuit board connector when the grounding element is in the grounding position. Mounting the circuit board connector on the circuit board may either be performed before arranging the circuit board and the grounding part with respect to each other or it may be performed thereafter.

[0009] In the following, some explanations of embodiments of the invention are given. For reasons of conciseness, focus is put on the circuit board connector according to the first aspect of the invention. The given explanations however correspondingly apply to the apparatus according to the second aspect of the invention and the method according to the third aspect of the invention. Furthermore, whenever it is referred to an apparatus in the context of a description of the circuit board connector according to the first aspect, the explanations provided with respect to the apparatus according to the second aspect of the present disclosure apply.

[0010] By mating the cable connector with the circuit board connector, the grounding element of the circuit board connector is transferred from the rest position to the grounding position. Thus, when the circuit board connector is in use, i.e. mounted on a circuit board of an apparatus and having the cable connector mated with it, the grounding element is in direct mechanical contact with a grounding part, e.g. a grounding part of the appa-

ratus. Accordingly, the grounding element is also in electric contact with the grounding part and may thus ensure that the circuit board connector is grounded, i.e. electrically connected to a defined ground potential, via its grounding element - potentially in addition to a ground connection established via a conductive path of the circuit board, in particular a conductive path electrically connected to a pin of the circuit board connector. A ground connection solely established via a conductive path of the circuit board may not ensure sufficient grounding, for instance because the limited circuit board area does not allow optimal routing of such a grounding path, as explained above.

[0011] Since the grounding element is transferable from the rest position to the grounding position by mating the cable connector with the circuit board connector, grounding of the circuit board connector may be automatically established when the cable connector is mated with the circuit board connector. It may thus be ensured that the circuit board connector is grounded via the grounding element when the circuit board connector is active, i.e. when a signal passes via the circuit board connector, e.g. a signal originating from a device connected to the circuit board connector via the cable connector and a cable to which it is attached. Furthermore, since the grounding part is distinct from the circuit board and the circuit board connector and since, in the grounding position, the grounding element is in direct mechanical contact with the grounding part, sufficient grounding of the circuit board connector may be achieved. This may in particular be due to the quality of the grounding of the circuit board connector not being limited by the grounding capabilities available through the circuit board - either directly or via the circuit board connector. Noise caused by a signal passing by the circuit board connector may be led off via the grounding element and absorbed by the grounding part. Even if the circuit board is designed to carry a multitude of signals of a wide frequency range, the signal to be conducted via the circuit board connector is a high frequency signal and/or differential signaling is used, electromagnetic emissions may still be kept low, comparatively strict EMC criteria may be met and EMC tests may thus be passed. As compared to grounding techniques solely involving the provision of a conductive path on the circuit board for establishing an electrical connection of the circuit board connector to a part having an electric potential defined as ground potential via the conductive path and a grounding electrode, for instance, limitations regarding the available circuit board area, may be essentially irrelevant.

[0012] The circuit board may be any circuit board designed to have electrical components arranged thereon and to establish electrical connections between several of such components and/or other electric components, e.g. electric components arranged at different locations within an apparatus in which the circuit board is arranged or external to such an apparatus. In particular, the circuit board may be a printed circuit board (PCB).

[0013] The circuit board connector may have several pins, e.g. one or more data signal pins, one or more control signal pins and one or more grounding pins that are distinct from the grounding element as described herein and that are connected to the circuit board itself for grounding. The one or more grounding pins may for instance be at least partially arranged in a receptacle of the circuit board connector or on a plug of the circuit board connector as is known in the art. The circuit board connector may for instance be a High Definition Multimedia Interface (HDMI) connector of any of the HDMI connector types, a Universal Serial Bus (USB) connector, a D-sub connector, a DIN connector, a cinch connector, a SCART connector or a Serial AT Attachment (SATA) connector, to name but a few non-limiting examples. Accordingly, the cable connector may be any corresponding connector configured to mate with the circuit board connector and configured to be attached to a cable for connecting another device to the circuit board via the circuit board connector. The circuit board connector may for instance be configured to have the cable connector mated from a direction perpendicular to a circuit board surface on which the circuit board connector is mounted or is to be mounted. Accordingly configured circuit board connector are sometimes referred to as a vertical circuit board connectors.

[0014] The grounding element may be any electrically conductive element. It may for instance be a pin, but other geometries are likewise possible. To give but one further example, the grounding element may have an angled or thickened end portion for obtaining a larger contact area with the grounding part in the grounding position. The grounding element may be guided by a guiding member, i.e. the circuit board connector may comprise a guiding member configured to guide the grounding element. The guiding member may for instance limit movement of the grounding element in a direction perpendicular to a direction of movement of the grounding element when it is transferred from the rest position to the grounding position. It may thereby also act as a support for the grounding element. Alternatively or in addition, the grounding element may be guided/supported by a passage in the circuit board connector and/or in the circuit board. The guiding member may be electrically conductive and may be in mechanical and electrical contact with another (electrically conductive) part of the circuit board connector, e.g. a base portion or a receptacle thereof. It may further be in mechanical and electrical contact with the grounding element - without, however, applying so much friction on the grounding element that it cannot move from the rest position to the grounding position. The guiding member may thereby establish an electrical connection between the grounding element and the other (electrically conductive) part of the circuit board connector, e.g. the base portion or the receptacle.

[0015] At least in when in the grounding position, the grounding element may also be in electrical contact with another electrically conductive component of the circuit

board connector, for instance a receptacle thereof, without an intervening guiding member establishing said electrical contact. However, this may apply for the rest position as well. In the grounding position, the grounding element may also be in electrical contact with a portion of the cable connector. The grounding element may be provided as an extra grounding element in addition to a grounding pin of the circuit board connector electrically connected to a conductive grounding path provided on the circuit board.

[0016] The circuit board connector may have more than one grounding element configured in accordance with the present disclosure. To name but one non-limiting example, two grounding elements may be provided on opposing sides of the circuit board connector. Providing more than one grounding element may further improve circuit board connector grounding and may thus reduce electromagnetic emissions even more. It may also introduce redundancy and thus contribute to more reliable grounding.

[0017] The grounding part may be any part distinct from the circuit board and the circuit board connector. It may for instance be a metal part. The electric potential of the grounding part may be defined as ground potential.

[0018] As noted above, the grounding position is a position for grounding the circuit board connector by means of a direct mechanical contact between the grounding element and the grounding part. Thus, when the circuit board connector is mounted on the circuit board, the grounding part is provided at its intended location and the grounding element is in its grounding position and the direct mechanical contact between the grounding element and the grounding part is established. For instance, an end portion of the grounding element, e.g. a tip of the grounding element, may mechanically contact the grounding part. When the mechanical contact is established, an electrical contact between the grounding part and the grounding element is established as well.

[0019] By contrast, the rest position may be characterized by the absence of a direct mechanical contact between the grounding element and the grounding part. For instance, an end portion of the grounding element that is in direct mechanical contact with the grounding part when it is in the grounding position may be spaced apart from the grounding part.

[0020] That the grounding element is transferable from the rest position to a grounding position may correspond to the grounding element being movable from the rest position to the grounding position. The grounding element may therefore be movably mounted at or in the circuit board connector. The transfer or movement may for instance be a linear movement. Other movement patterns are however likewise possible. In order to induce the transfer or movement of the grounding element from the rest position to the grounding position when mating the cable connector and the circuit board connector, e.g. to push or pull the grounding element into the grounding position, the cable connector may have at least one

engaging portion configured to mechanically engage with an engaging portion of the grounding element.

[0021] The grounding element may also be transferable from the grounding position to the rest position. For instance, the grounding element may be configured to automatically transfer from the grounding position to the rest position when the circuit board connector and the cable connector are disconnected. For the transfer from the grounding position to the rest position, the above explanation re the transfer in the opposite direction apply *mutatis mutandis*.

[0022] According to one variant, the grounding element is biased to the rest position. Thus, the grounding element may assume the rest position unless the circuit board connector and the cable connector are mated. Further, being biased to the rest position, the grounding element may be configured to automatically transfer from the grounding position to the rest position when the circuit board connector and the cable connector are disconnected.

[0023] The bias of the grounding element to the rest position may for instance be achieved by means of a biasing element, e.g. an elastic member, for instance a spring, engaging with the grounding element. The biasing element may for instance be arranged between a portion of the grounding element, e.g. a portion of the grounding element configured to engage with the biasing element, and another part of the circuit board connector or the circuit board. The biasing element may be electrically conductive. It may thereby establish an electrical connection of the grounding element to another part of the circuit board connector, e.g. the receptacle. The biasing element may be configured to support the grounding element - alone or in addition to a guiding member that also serves this purpose. The biasing element may or may not be fixedly attached to the grounding element. At another end, the biasing element may or may not be fixedly attached to another part of the circuit board connector or the circuit board. A blocking element configured to limit the movement of the grounding element due to a force exerted on the grounding element by the biasing element may be provided. It may or may not be integrally formed with a guiding member for the grounding element.

[0024] The weight of a cable connector mated with the circuit board connector and of the cable attached thereto may ensure that the bias of the grounding element does not result in a spontaneous and undesired transfer of the grounding element from the grounding position to the rest position. Alternatively or in addition or locking means provided to this end may also serve this purpose.

[0025] According to one variant, the circuit board connector comprises a receptacle configured to receive the cable connector and mating the cable connector with the circuit board connector comprises inserting the cable connector into the receptacle. In the context of this variant, the cable connector may also be referred to as a plug. According to another variant, however, the cable connector may have a receptacle configured to receive

the circuit board connector.

[0026] In one implementation of the above variant, the grounding element has a grounding portion arranged outside the receptacle and an engaging portion extending into the receptacle. Therein, the grounding portion has an end portion configured to directly mechanically contact the grounding part in the grounding position and the engaging portion is configured to mechanically engage with the cable connector when the cable connector is inserted into the receptacle, thereby allowing the cable connector to transfer the grounding element from the rest position to the grounding position. Since the grounding portion is arranged outside the receptacle, less space within the receptacle may be used as compared to an implementation wherein the grounding portion is likewise at least partially accommodated by the receptacle. According to the presently discussed implementation, the engaging portion of the grounding element and its grounding portion may be angled with respect to each other. For instance, the engaging portion may extend into the receptacle in a direction substantially parallel to a circuit board mounting surface. By contrast, the grounding portion of the grounding element may mainly extend in a direction substantially perpendicular to the circuit board mounting surface.

[0027] The receptacle may comprise a lateral recess thorough which the engaging portion of the grounding element extends into the receptacle. Providing such a recess, e.g. a slit, in the receptacle, might deteriorate an electrical shielding property of an electrically conductive receptacle. However, this may be uncritical since sufficient grounding of the circuit board connector may be achieved via the grounding element when the cable connector is received in the receptacle. If the cable connector is not received in the receptacle, the circuit board connector is anyway not in use. The recess may be designed so as not to obstruct a movement of the grounding element when it is transferred from the rest position to the grounding position, e.g. the position of the recess and also its length may be chosen accordingly.

[0028] A channel allowing the grounding portion of the grounding element to pass through the circuit board connector, in particular a base portion thereof, and/or a channel or passage allowing the grounding portion to pass through the circuit board it according to its thickness may be provided. The channels may also guide and support the grounding element.

[0029] In one implementation wherein the grounding element is biased to the rest position, the biasing element is arranged between the engaging portion of the grounding element and a base area, e.g. a bottom wall, of the receptacle. Thus, the biasing element may support the grounding element on the base area of the receptacle. If the biasing element is electrically conductive, it may then establish an electrical connection between the grounding element and the receptacle via its base area. The biasing element may be at least partially arranged in the lateral recess of the receptacle, which may result in an efficient

use of space, in particular yield a comparatively low use of space within the receptacle.

[0030] In one implementation, the grounding element may have a grounding portion arranged inside the receptacle and an engaging portion angled with respect to the grounding portion, wherein both the grounding portion and the engaging portion are accommodated by the receptacle. Therein, the grounding portion has an end portion configured to directly mechanically contact the grounding part in the grounding position and the engaging portion is configured to mechanically engage with the cable connector when the cable connector is inserted into the receptacle. A channel allowing the grounding portion to pass through the circuit board connector and having an opening at a base area, e.g. a bottom wall, of the receptacle may be provided. A corresponding channel passage may be provided in the circuit board to allow the grounding element to pass through it according to its thickness. Again, the grounding element may be biased to the rest position by means of a (possible electrically conductive) biasing element arranged between the engaging portion of the grounding element and a base area, e.g. a bottom wall, of the receptacle. Thus, the biasing element may support the grounding element at the base area of the receptacle. The biasing element may also surround the grounding portion of the grounding element at least partially and may still engage with the engaging portion of the grounding element.

[0031] According to one variant, the grounding element is configured to perform a movement in a direction perpendicular to a circuit board mounting surface when it is transferred from the rest position to the grounding position. Thus, leaving a neighboring circuit board area unoccupied so that the grounding element has space to move may be unnecessary.

[0032] According to one implementation of the above variant, an end portion of the grounding element is configured to penetrate the circuit board in the grounding position. To this end, the circuit board may have a passage provide therein that allows the grounding element to pass through it according to its thickness. Thus, when the circuit board connector is mounted on a first surface of the circuit board, at least a portion of the grounding element may extend beyond an opposing second surface of the circuit board to a grounding part provided there. Mating the cable connector and the circuit board connector may thus be performed unobstructed by the grounding part. In one implementation, the end portion of the grounding element may be configured to solely extend to the circuit board connector mounting surface and/or within the circuit board in the rest position. In this case, the grounding element does not protrude beyond the surface of the circuit board oriented towards the grounding part.

[0033] If a circuit board connector were to be grounded by means of a relatively long grounding element designed to permanently penetrate a circuit board on which the circuit board connector is mounted so as to contact

a grounding part provided at the other side, problems might occur when the pin in hole reflow (PIHR) process, which is also known as "pin in paste" or "through-hole reflow" process, is used for through-hole technology (THT) mounting of the circuit board connector. The molten solder paste could then flow along the edges of the relatively long grounding element to an end portion or tip of the grounding element. A cold solder problem could thus occur there. This could prevent proper electrical contact of the grounding element to a grounding part. This problem may be avoided by employing a circuit board connector having a grounding element that is transferable from a rest to a grounding position by mating a cable connector with the circuit board connector. When mounting the circuit board connector on a mounting surface of a circuit board, the grounding element may be in the rest position, e.g. due to being biased to the rest position. A portion of it extending into the molten solder or through the molten solder beyond an opposing surface of the circuit board may have a shorter length. Therefore, a lesser quantity of solder may accumulate the grounding element surface at then reach the end portion or tip of the grounding element. The PIHR process may then be used without causing the above-explained problem.

[0034] According to one variant of, the grounding part is a part of a housing of an apparatus in which the circuit board connector and the circuit board are to be arranged. Thus, a part that may have to be provided anyway since it is needed for accommodating the circuit board and the connector may additionally serve as the grounding part whose potential is defined as ground potential. Grounding techniques involving defining the electric potential of a housing part as ground potential are referred to as chassis grounding.

[0035] According to one variant, the circuit board connector is configured to mate with a user device cable connector. Such a circuit board connector may be referred to as a user device circuit board connector, for instance. By providing a user device circuit board connector with a grounding element as disclosed herein, it may be ensured that when a user connects a user device to the circuit board connector by means of a cable having the cable connector attached thereto, grounding of the circuit board connector via the grounding element is established. As there is a risk that a user forgets establishing extra circuit board connector grounding manually, a circuit board connector configured to automatically establishing it when the cable connector of a user device and the circuit board connector are mated may be particularly beneficial. The user device may for instance be any device connectable to the circuit board connector by means of a cable connector and attached cable by a user, e.g. as compared to devices that are usually connected to the circuit board connector by manufacturing, assembly or maintenance personnel. In many cases, a user device circuit board connector is comparatively easily accessible. For instance, a housing may have an opening that provides access to the user device circuit board con-

connector. By contrast, a circuit board connector designed to be used by manufacturing, assembly or maintenance personnel is in many cases only accessible by opening a housing, which may involve removing fastening means such as screws or the like. However, access to a user device circuit board connector may sometimes require opening a housing, whereas access to a circuit board connector designed to be used by manufacturing, assembly or maintenance personnel may be possible without doing so. For instance, the user device may be a peripheral or accessory device to an apparatus comprising the circuit board connector. As an example, if the apparatus is a TV set, the peripheral or accessory device may for instance be a CD player, a DVD player, a Blu-ray player or a digital video recorder.

[0036] According to one variant, the circuit board is one of a backplane, a mainboard and an expansion card. The circuit board, backplane, mainboard or expansion card may be installed in an apparatus, in particular and apparatus according to the second aspect of the present invention.

[0037] The embodiments described above and in particular their single features shall be understood to be disclosed in all possible combinations with each other.

[0038] These and further concepts of the invention will be apparent from and elucidated with reference to the detailed description presented hereinafter. While the detailed description focuses on HDMI circuit board connectors, it will be understood that this is merely an example and the concepts of the invention may be applied to other types of circuit board connectors equally well.

[0039] In the figures show:

Fig. 1A a schematic illustration of an embodiment of an apparatus according to the second aspect of the present invention, the apparatus comprising an embodiment of a circuit board connector according to the first aspect of the present invention, wherein a cable connector is not mated with the circuit board connector;

Fig. 1B a schematic illustration of the apparatus of Fig. 1A, wherein a cable connector is mated with the circuit board connector;

Fig. 1C a schematic illustration of a cross section of a receptacle of the apparatus of Fig. 1A;

Fig. 2 a flowchart schematically illustrating an embodiment of a method according to the third aspect of the present invention.

[0040] Fig. 1A shows a schematic illustration of an embodiment of an apparatus 100 according to the second aspect of the present invention. The apparatus 100 comprises an embodiment of a circuit board connector 200 according to the first aspect of the present invention and a PCB 110 arranged in a housing 120, e.g. a metal hous-

ing, of apparatus 100. The electric potential of a part 121 of housing 120, e.g. a cover forming part of housing 120, is defined as ground potential in apparatus 100. Circuit board connector 200 is mounted on a first side 111 of PCB 110. Apparatus 100 may for instance be a PC, a notebook or tablet computer, a server or an entertainment device such as a TV set, a CD player, a DVD player, a blu-ray player or a digital video recorder. PCB 110 may for instance be a mainboard PCB of apparatus 100 or a PCB of an expansion card installed therein. More than one circuit board connector may be provided on PCB 110. For instance, several circuit board connectors configured such as circuit board connector 200 may be provided or one or more differently configured circuit board connectors may be provided in addition to circuit board connector 200.

[0041] In the present example, circuit board connector 200 is an HDMI circuit board connector. Circuit board connector 200 is configured to mate with a corresponding HDMI cable connector (not shown in Fig. 1A). To this end, it has a receptacle 210 formed as a metal shell and configured receive the cable connector, i.e. the HDMI plug. The HDMI plug can be inserted into receptacle 210 through an opening 211. Circuit board connector 200 is thus configured to have the HDMI plug mated from a direction perpendicular to circuit board connector mounting surface 111 of PCB 110 and is therefore a vertical circuit board connector.

[0042] Circuit board connector 200 has data, clock and control signal pins as well as a grounding pin. The pins have solder portions 240 that are to be soldered to corresponding conductive paths on PCB 110. The solder portion 240 of the grounding pin may be soldered to a conductive path on a second surface 112 of PCB 110 for establishing an electrical connection of circuit board connector 200 to a grounding part, e.g. housing part 121, via the conductive path and a grounding electrode electrically connected to another end of the conductive path. The solder portions 240 of the other pins may be soldered to respective other conductive paths on second surface 112 of PCB 110. The pins of the circuit board connector 200 correspond to those of an HDMI plug with which it is configured to mate.

[0043] In addition to the HDMI grounding pin having a solder portion 240, two electrically conductive, movably mounted metal extra grounding pins 220 and 230 are additionally provided at opposing sides of circuit board connector 200, specifically at opposing sides of receptacle 210. Grounding pin 220 has a grounding portion 221 that is arranged outside of receptacle 210. The principal axis of grounding portion 221 extends in a direction perpendicular to circuit board connector mounting surface 111 of PCB 110. Grounding pin 220 further has an engaging portion or ledge 222 extending into receptacle 210 through a recess or slit 213 provided in a lateral wall of receptacle 210. Engaging portion 222 is arranged at a 90° angle with respect to grounding portion 221, i.e. engaging portion 222 extends in a direction parallel to

circuit board connector mounting surface 111. Engaging portion 222 is configured to mechanically engage with a cable connector, i.e. HDMI plug, when the cable connector is inserted into receptacle 210. Grounding pin 230 likewise has a grounding portion 231 that is arranged outside of receptacle 210 and an engaging portion or ledge 232 extending into receptacle 210 through a corresponding recess or slit 214. In Fig. 1A, lower ends of grounding portions 221, 231 pass through respective channels (not visible) provided in a base portion of receptacle 210 in a direction perpendicular to the plane of PCB 110. Grounding pins 220, 230 are both in electrical contact with other parts of circuit board connector 200 as will be further explained below.

[0044] In Fig. 1A, no cable connector is mated with circuit board connector 200. Grounding pins 220, 230 are therefore both in a rest position to which they are biased by biasing elements in the form of metallic springs 240 and 250, respectively. As shown in Fig. 1A, springs 240 and 250 are arranged in recesses 213 and 214, respectively. Spring 240 is further arranged between engaging portion 222 of grounding pin 220 and a base area 212, i.e. bottom portion, of receptacle 210. Spring 240 thus supports grounding pin 220 on base area 212. Spring 240 may be fixedly attached to engaging portion 222 and/or to base area 212. Alternatively, it may merely be inserted between engaging portion 222 and base area 212 without being fixedly attached to any of them. Spring 250 is arranged between engaging portion 232 of grounding pin 230 and base area 212 of receptacle 210 in a similar manner and supports grounding pin 230. Being made of an electrically conductive material, spring 240 establishes an electrical connection between grounding pin 220 and receptacle 210, specifically its base area 212. Spring 250 establishes an electrical connection between grounding pin 230 and receptacle 210.

[0045] A duct 260 is provided as a guiding member for grounding pin 220. Duct 260 laterally surrounds a part of grounding portion 221 of grounding pin 220 at a side thereof opposing receptacle 210. Duct 260 also surrounds said part of the grounding portion 221 at a front side and a rear side thereof, e.g. it may have a portion having a segment of a circle cross section. In Fig. 1A, however, a longitudinal section through duct 260 is shown so as not to cover grounding pin 220. Duct 260 thus limits movement of grounding pin 220 in a direction perpendicular to the direction in which grounding pin 220 mainly extends (vertically in Fig. 1A). At a first end (lower end in Fig. 1A), duct 260 is supported by an electrically conductive, e.g. metallic, base portion of circuit board connector 200. At an opposing second end (upper end in Fig. 1A), duct 260 comprises an angled portion 261 abutting receptacle 210 laterally. Although duct 260 directly adjoins receptacle 210 and communicates with recess 213, it is not considered as a part of receptacle 210 in the context of the present disclosure so that grounding portion 221 of pin 220 considered to be arranged outside of receptacle 210. Duct 260 is made of an electrically

conductive material, e.g. metal. An accordingly designed electrically conductive duct 270 having an angled portion 271 is provided as a guiding member for grounding pin 220. In the context of the present disclosure, also duct 270 is not considered as a part of receptacle 210.

[0046] Springs 240, 250 engage with engaging portions 222, 232 of grounding pins 220, 230, respectively, and push them in a direction away from housing part 121 (upwards in Fig. 1A). Movement in said direction is limited by angled portions 261, 271 of ducts 260, 270. Ducts 260, 270 thus serve as blocking elements for the grounding pins. In the rest position, engaging portions 222, 232 of grounding pins 220, 230 abut angled portions 261, 271, respectively, at an inner side thereof. Grounding pin 220 is in mechanical contact with duct 260. More specifically, engaging portion 222 of grounding pin 220 is in mechanical contact with angled portion 261 of duct 260 and grounding portion 221 of grounding pin 220 is in mechanical contact at least with a laterally surrounding portion of duct 260. The friction occurring between grounding portion 221 and the laterally surrounding portion of duct 260 is however not so massive that it could completely block a movement of grounding pin 220 from the rest position to the grounding position. Grounding pin 230 is in mechanical contact with duct 270 in the same manner.

[0047] Since duct 260 is electrically conductive and since it is supported by a base portion of circuit board connector 200 and also abuts its receptacle 210, electrical connections between duct 260 and the base portion as well as between duct 260 and receptacle 210 are established. Since electrically conductive grounding pin 220 mechanically contacts duct 260, electrical connections between grounding pin 220 and the base portion of circuit board connector 200 as well as between grounding pin 220 and receptacle 210 are established through duct 260. In the same manner, electrical connections between grounding pin 230 and the base portion of circuit board connector 200 as well as between grounding pin 230 and receptacle 210 are established through duct 270.

[0048] Fig. 1C is a schematic illustration of a cross section of receptacle 210 of circuit board connector 200 of Fig. 1A. As can be seen in the figure, engaging portion 222 of grounding pin 220 extends into receptacle 210 through lateral recess 213. Spring 240 (not visible in Fig. 1C) is arranged in recess 213 and between base area 212 of receptacle 210 and engaging portion 222. Since spring 240 is arranged in recess 213, as compared to arranging the spring 240 further towards the center of receptacle 210, less space within receptacle 210 may be used. Since grounding portion 222 is supported by spring 240 in recess 213, grounding portion 222 may need to extend less far into receptacle 210. Similarly, engaging portion 232 of grounding pin 230 extends into receptacle 210 through lateral recess 214 in which spring 250 (not visible in Fig. 1C) is arranged. As apparent from Fig. 1A, duct 260 has a portion having a semicircular cross section and surrounding grounding portion 221 of grounding pin 220. Duct 270 likewise has a portion having a semicircular

cross section and surrounding grounding portion 231 of grounding pin 230. In the cross sectional view of Fig. 1C, angled portions 261, 271 of ducts 260, 270 are not visible.

[0049] Returning to Fig. 1A, in the rest position, grounding pins 220, 230 do not mechanically contact housing part 121. In Fig. 1A, they do not even extend beyond second surface 112 of PCB 110 (downside of PCB 110 in Fig. 1A) opposite to circuit board connector mounting surface 111, but the end portions of their grounding portions 221, 231 oriented towards housing part 121 are flush with respective openings terminating passages 113, 114 that pass through PCB 110 according to its thickness, the openings being located in the plane with the second surface 112 of PCB 110. Grounding pins 220, 230 thus solely extend to the side of circuit board 110 on which circuit board connector 200 is mounted and within passages 113, 114. They do not protrude beyond second surface 112 of PCB 110 oriented towards housing part 121.

[0050] However, as will be explained in more detail in the following, grounding pins 220, 230 are transferable from the rest position to a grounding position.

[0051] Fig. 1B is a schematic illustration of apparatus 100 of Fig. 1A, wherein a cable connector 310 is mated with circuit board connector 200 (in Fig. 1B cable connector 310 is shown with a dashed outline since it is accommodated in receptacle 210). Cable connector 310, i.e. the HDMI plug, is attached to an HDMI cable 300. When mating the cable connector 310 of HDMI cable 300 with circuit board connector 200 by inserting HDMI connector 310 into receptacle 210 of circuit board connector 200 through its opening 211, portions of HDMI plug 310 engage with engaging portions 222, 232 of grounding pins 220, 230, respectively, so that a force is exerted on each of grounding pins 220, 230, when HDMI plug 310 is inserted into receptacle 210. Said force pushes grounding pins 220, 230 towards housing part 121 in a direction perpendicular to circuit board connector mounting surface 111 of PCB 110 and through the corresponding channels provided in the base portion of receptacle 210 and through circuit board passages 113, 114 so that grounding pins 220, 230 perform a corresponding linear movement against the force of springs 240, 250. Since grounding pins 220, 230 are configured to move in a direction perpendicular to circuit board connector mounting surface 111, leaving circuit board area unoccupied in order to provide space for grounding pins 220, 230 to move may be unnecessary.

[0052] When HDMI plug 310 is fully received in receptacle 210, i.e. when circuit board connector 200 and HDMI plug 310 are mated, grounding pins 220, 230 penetrate PCB 110. An end portion of each of the grounding portions 221, 231 of grounding pin 220, 230 touches housing part 121. Each grounding pin 220, 230 is thus in direct mechanical contact to housing part 121. Grounding pins 220, 230 are in the grounding position. For an increased contact area, each of grounding portions 221,

231 of pins 220, 230 may have may have an angled or thickened end portion. Grounding pins 220, 230 are thus transferable from the rest position to the grounding position by mating HDMI plug 310 with HDMI circuit board connector 200. In the grounding position, an electrical connection to the housing part 121 having an electric potential defined as ground potential is thus established via grounding pins 220, 230 (and springs 240, 250 and ducts 260, 270) so that circuit board connector 200 is grounded via grounding pins 220, 230. The weight of HDMI plug 310 and of cable 300 keeps grounding pins 220, 230 in the grounding position against the force exerted by springs 240, 250 on grounding pin engaging portions 222, 232.

[0053] By mating HDMI cable connector 310 with the HDMI circuit board connector 200, circuit board connector 200 is thus automatically grounded via grounding pins 220, 230 in addition to the ground connection established via the HDMI grounding pin, the conductive path on second side 112 of PCB 110 to which solder portion 240 of the HDMI grounding pin is soldered and a grounding electrode connected thereto. When circuit board connector 200 is active, i.e. when a signal passes via circuit board connector 200 and mating HDMI plug 310, appropriate grounding of circuit board connector 200 may thus be ensured. Furthermore, since housing part 121 is distinct from PCB 110 and from circuit board connector 200 and since grounding pins 220, 230 are in direct mechanical contact with the grounding part, sufficient grounding of circuit board connector 200 may be achieved. Noise caused by a signal passing circuit board connector 200 may be led of via grounding pins 220, 230 and absorbed by housing part 121. Even if PCB 110 carries a multitude of signals of a wide frequency range, and despite high frequency differential signals passing circuit board connector 200, electromagnetic emissions may still be kept low, comparatively strict EMC criteria may be met and EMC tests may thus be passed by apparatus 100. As compared to the grounding connecting via the HDMI grounding pin, the conductive grounding path on PCB 110 to which it is soldered, and a grounding electrode, limitations regarding the available circuit board area, which may lead to sub-optimal routing of the conductive grounding path and relatively weak connection to ground, may play a less critical role for the grounding via grounding pins 220, 230. That lateral recesses 213, 214 that are provided in receptacle 210 so that engaging portions 222, 232 of grounding pins 220, 230 can extend into it might deteriorate an electrical shielding property of receptacle 210. However, this is uncritical since sufficient grounding of circuit board connector 200 may be achieved via grounding pins 220, 230 when HDMI plug 310 is received in receptacle 210. If HDMI plug 310 is not received in receptacle 210, circuit board connector 200 is anyway not active. Since not only one grounding pin but two grounding pins 220, 230 are provided, circuit board connector 200 is grounded particularly well, which may reduce electromagnetic emissions even more, and redun-

dancy is provided so that grounding is made more reliable. The symmetric arrangement of grounding pins 220, 230 with respect to receptacle 210 may further prevent tilting of HDMI plug 310.

[0054] Since, in the rest position, grounding pins 220, 230 do not extend beyond second surface 112 of PCB 110, the pin in hole reflow (PIHR) process may be used for connecting electrical components on circuit board connector mounting surface 111 of PCB 110 without causing the problem of a critical quantity of molten solder accumulating at the surface of grounding pins 220, 230, specifically their grounding portions 221, 231. It may therefore be avoided that a critical quantity of molten solder reaches the end portions of grounding portions 221, 231 and causes a cold solder problem there.

[0055] Circuit board connector 200 may be used by a user to connect a user device to apparatus 100 via HDMI cable 300 and attached HDMI plug 310. For instance, the user device may be a peripheral or accessory device to apparatus 100. To give but two examples, if apparatus 100 is a TV set, the peripheral or accessory device may for instance be a DVD player, a blu-ray player or a digital video recorder. If the apparatus 100 is a PC, the peripheral device may for instance be a display. As compared to technologically adept individuals, e.g. manufacturing, assembly or maintenance personnel, users are particularly prone to forgetting establishing extra grounding of circuit board connector 200 manually. It may therefore be particularly beneficial that extra grounding of circuit board connector 200 via grounding pins 220, 230 is established by mating HDMI plug 310 of cable 300 connected to the user device with circuit board connector 200 and does not require the user to perform any intentional action for establishing the extra grounding. In the present example, direct user access to components inside housing 120 is not also required to this end.

[0056] When HDMI cable connector or plug 310 is disconnected from circuit board connector 200, HDMI plug 310 ceases to exert a force on grounding pins 220, 230. Since grounding pins 220, 230 are biased to the rest position by springs 240 and 250, respectively, they automatically transfer back to the rest position.

[0057] Fig. 2 is a flowchart 400 schematically illustrating an embodiment of a method according to the third aspect of the present invention.

[0058] Block 410 of flowchart 400 comprises mounting a circuit board connector configured to mate with a cable connector on a circuit board. The circuit board connector comprises at least one grounding element transferable from a rest position to a grounding position by mating the cable connector with the circuit board connector. For instance, the circuit board connector that is mounted may be circuit board connector 200 illustrated in Fig. 1A and Fig. 1B and it may be mounted on circuit board 110 of apparatus 100 shown in these figures.

[0059] Block 420 of flowchart 400 comprises arranging the circuit board and a grounding part distinct from the circuit board and distinct from the circuit board connector,

for instance housing part 121 illustrated in Fig. 1A and Fig. 1B, with respect to each other such that for grounding the circuit board connector, the grounding element, e.g. grounding pins 220, 230 of circuit board connector 200, is in direct mechanical contact with the grounding part, for instance housing part 121, when the grounding element is in the grounding position. Arranging the circuit board and the grounding part with respect to each other may for instance comprise choosing an appropriate distance between the circuit board and the grounding part, taking into account the travel of the grounding element from the rest position to the grounding position. Arranging the circuit board and the grounding part with respect to each other may for instance comprise installing the circuit board in a housing of which the grounding part forms part, e.g. housing 120 of Fig. 1A and Fig. 1B.

[0060] The order of blocks 410 and 420 may be reversed. Thus, the circuit board may be arranged in proper alignment with and at a suitable distance to the grounding part before the circuit board connector is mounted thereon.

Claims

1. A circuit board connector (200) configured to be mounted on a circuit board (110) and configured to mate with a cable connector (310),
 - wherein the circuit board connector (200) comprises at least one grounding element (220, 230) transferable from a rest position to a grounding position by mating the cable connector (310) with the circuit board connector (200) and
 - wherein the grounding position is a position for grounding the circuit board connector (200) by means of a direct mechanical contact between the grounding element (220, 230) and a grounding part (121) distinct from the circuit board (110) and distinct from the circuit board connector (200).
2. The circuit board connector (200) of claim 1, wherein the grounding element (220, 230) is biased to the rest position.
3. The circuit board connector (200) of any of the preceding claims, wherein the circuit board connector (200) comprises a receptacle (210) configured to receive the cable connector (310) and wherein mating the cable connector (310) with the circuit board connector (200) comprises inserting the cable connector (310) into the receptacle (210).
4. The circuit board connector (200) of claim 3, wherein
 - the grounding element (220, 230) has a grounding portion (221, 231) arranged outside

the receptacle (210) and an engaging portion (222, 232) extending into the receptacle (210);

- the grounding portion (221, 231) has an end portion configured to mechanically contact the grounding part (121) in the grounding position; and
- the engaging portion (222, 232) is configured to mechanically engage with the cable connector (310) when the cable connector (310) is inserted into the receptacle (210), thereby allowing the cable connector (310) to transfer the grounding element (220, 230) from the rest position to the grounding position.

5. The circuit board connector (200) of claim 4, wherein the receptacle (210) comprises a lateral recess (213, 214) thorough which the engaging portion (222, 232) of the grounding element (220, 230) extends into the receptacle (210).
6. The circuit board connector (200) of claim 2 and any of claims 4 and 5, wherein a biasing element (240, 250) is arranged between the engaging portion (222, 232) of the grounding element (220, 230) and a base area (212) of the receptacle (210).
7. The circuit board connector (200) of claims 5 and 6, wherein the biasing element (240, 250) is at least partially arranged in the lateral recess (213, 214) of the receptacle (210).
8. The circuit board connector (200) of any of the preceding claims, wherein the grounding element (220, 230) is configured to perform a movement in a direction perpendicular to a circuit board connector mounting surface (111) when it is transferred from the rest position to the grounding position.
9. The circuit board connector (200) of claim 8, wherein an end portion of the grounding element (220, 230) is configured to penetrate the circuit board (110) in the grounding position.
10. The circuit board connector (200) of claim 9, wherein the end portion of the grounding element (220, 230) is configured to solely extend to the circuit board connector mounting surface (111) and/or within the circuit board (110) in the rest position.
11. The circuit board connector (200) of any of the preceding claims, wherein the grounding part (121) is a part of a housing (120) of an apparatus (100) in which the circuit board connector (200) and the circuit board (110) are to be arranged.
12. The circuit board connector (200) of any of the preceding claims, wherein the circuit board connector (200) is configured to mate with a user device cable

connector (310).

13. The circuit board connector (200) of any of the preceding claims wherein the circuit board (110) is one of a backplane, a mainboard and an expansion card. 5

14. An apparatus (100) comprising:

- a circuit board (110),
- a circuit board connector (200) according to any of the preceding claims mounted on the circuit board (110) and 10
- a grounding part (121) distinct from the circuit board (110) and distinct from the circuit board connector (200). 15

15. A method comprising:

- mounting (410) a circuit board connector (200) configured to mate with a cable connector (310) on a circuit board (110), wherein the circuit board connector (200) comprises at least one grounding element (220, 230) transferable from a rest position to a grounding position by mating the cable connector (310) with the circuit board connector (200), 20
- arranging (420) the circuit board (110) and a grounding part (121) distinct from the circuit board and distinct from the circuit board connector (200) with respect to each other such that for grounding the circuit board connector (200) the grounding element (220, 230) is in direct mechanical contact with the grounding part (121) when the grounding element (220, 230) is in the grounding position. 25 30 35

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FIG1B

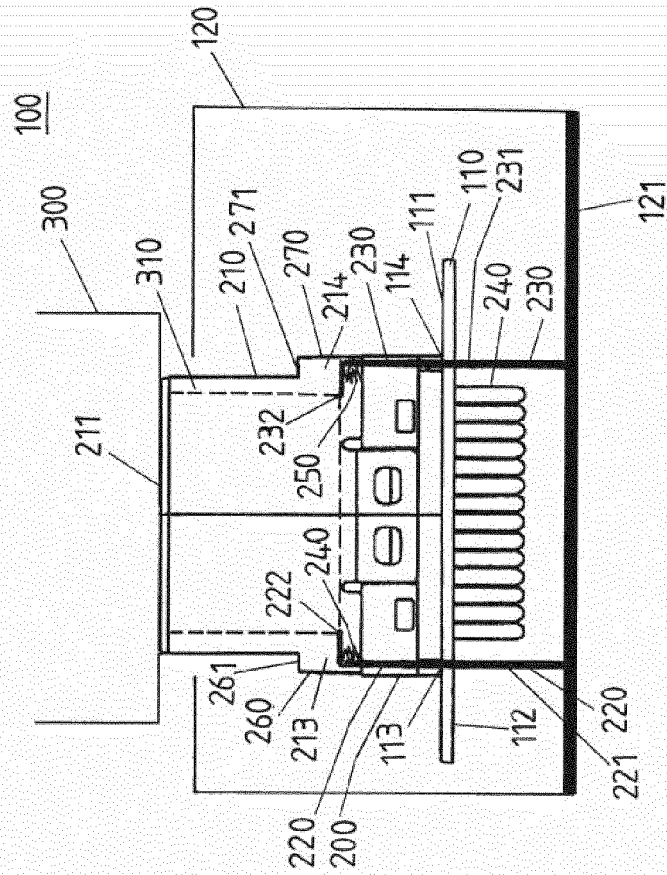


FIG1A

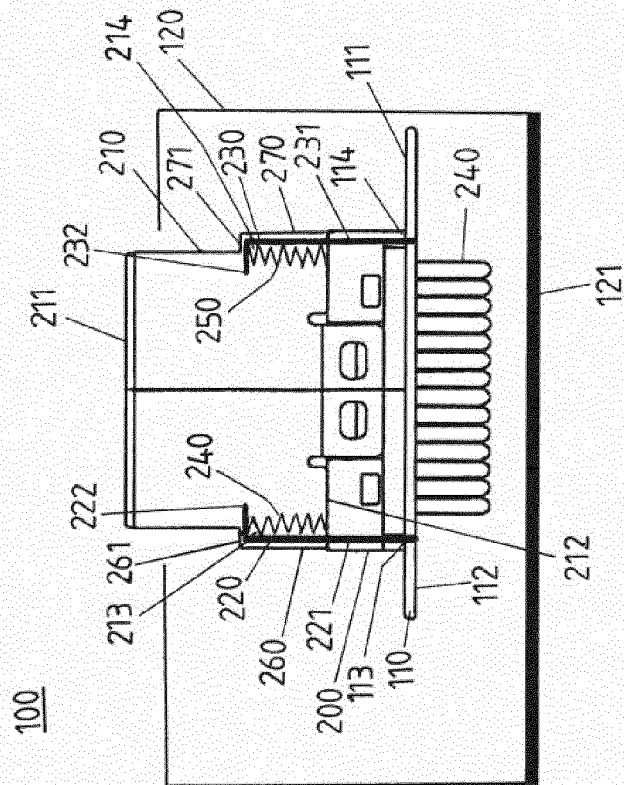


FIG 1C

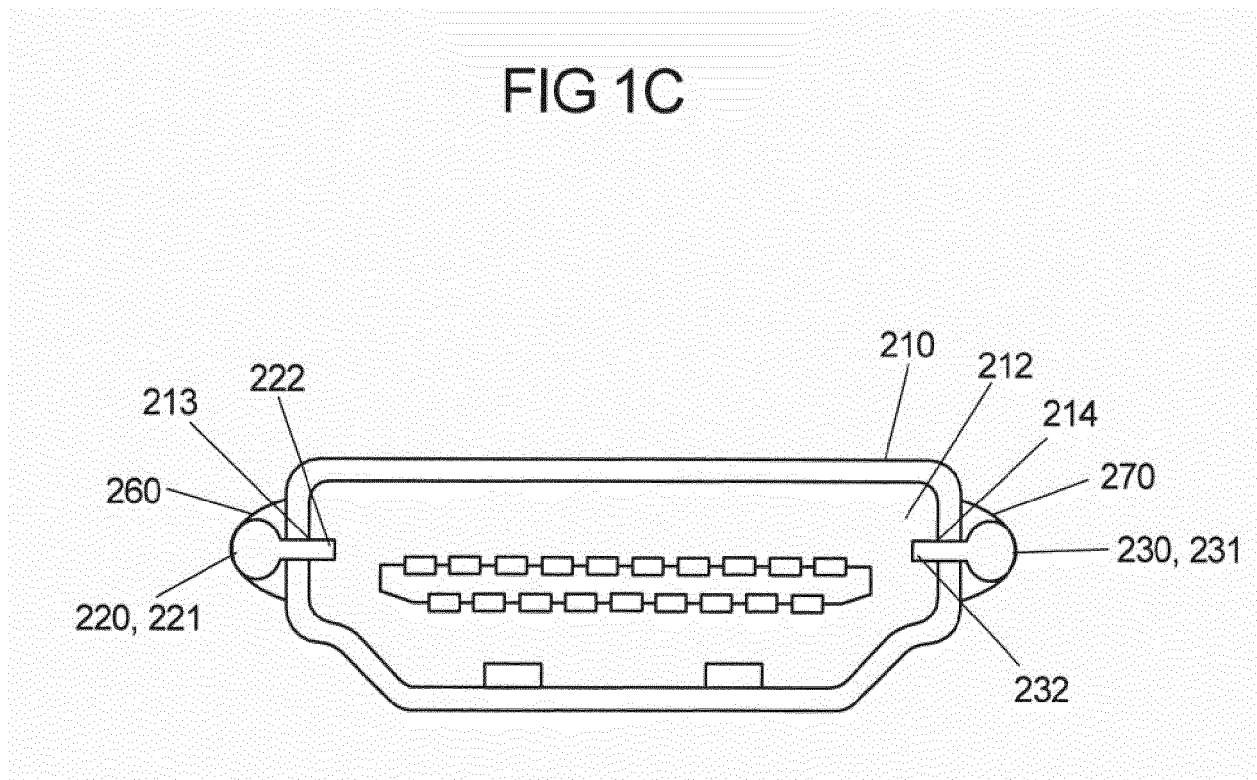
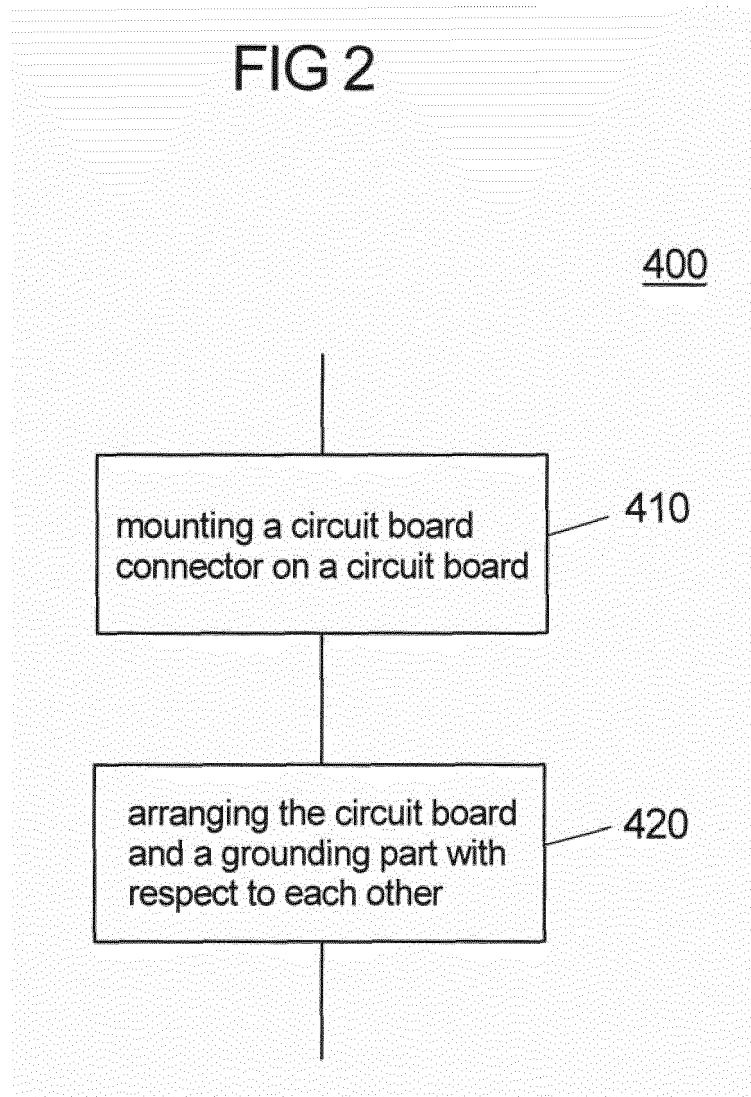


FIG 2





EUROPEAN SEARCH REPORT

Application Number
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Place of search The Hague		Date of completion of the search 12 April 2019	Examiner Ferreira, João
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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