

DESCRIPTION

HEAT SINK AND ELECTRONIC DEVICE UNIT

TECHNICAL FIELD

[0001] The present invention relates to a heat sink and an electronic device unit.

BACKGROUND ART

[0002] Conventionally, a heat sink has been known, which includes a base plate thermally connected to a heating element mounted on a substrate and a plurality of fins protruding from the base plate on a side opposite to the heating element.

CITATION LIST

Patent Literature

[0003] Patent Document 1: Japanese Patent Application Laid-open No. 2019-67888

SUMMARY OF INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0004] In a heat sink of that type, it is advantageous if a novel configuration adaptive to a fanless electronic device with less inconvenience is obtained.

MEANS FOR SOLVING PROBLEM

[0005] A heat sink according to an embodiment includes a base plate, a protrusion, first fins, a first boss, and a second boss. The protrusion protrudes from the base plate in a first direction intersecting the base plate. The protrusion is thermally connectable to a first heating element mounted on a first substrate. The first fins protrude from the base plate in an opposite direction to the first direction. The first fins are aligned in a second direction intersecting the first direction. The first boss protrudes from the base plate

more than the first fins in the opposite direction to the first direction. The first boss allows a fastener to be attached to the first boss. The fastener serves to couple an outer wall of a housing and the base plate. The second boss protrudes from the base plate in the first direction. The second boss allows a fastener to be attached to the second boss. The fastener serves to couple the first substrate and the base plate.

BRIEF DESCRIPTION OF DRAWINGS

[0006] FIG. 1 is an exemplary perspective view of an electronic device equipped with an electronic device unit including a heat sink in an embodiment.

FIG. 2 is an exemplary perspective view of the electronic device unit including the heat sink in the embodiment.

FIG. 3 is an exemplary perspective view from the back surface side of the heat sink in the embodiment.

FIG. 4 is an exemplary and schematic YZ sectional view of the electronic device of FIG. 1.

FIG. 5 is an exemplary and schematic XY sectional view of the electronic device of FIG. 1.

DESCRIPTION OF EMBODIMENTS

[0007] Exemplary embodiments of the present invention are disclosed below. The configuration of the embodiments described below and the operation and effect achieved by the configuration are provided only by way of example. The present invention can be embodied by a configuration other than the configuration disclosed in the following embodiments. The present invention can provide at least one of various effects (including derivative effects) achieved by the configuration.

[0008] In the present description, ordinal numbers are used merely for identifying parts, members, sections, positions, directions, and the like and are not intended to suggest any order or priorities.

[0009] [Embodiments]

FIG. 1 is a perspective view of an electronic device 1 equipped with an electronic device unit 10 (see FIG. 2) including a heat sink 3 described later. In the following drawings, three directions orthogonal to each other are defined for the sake of convenience. An X direction extends in the depth direction (front-back direction) of the electronic device 1 and extends in the lateral width direction of the heat sink 3. The Y direction extends in the width direction (right-left direction) of the electronic device 1 and extends in the thickness direction of the heat sink 3. The Z direction extends in the height direction (top-bottom direction) of the electronic device 1 and extends in the longitudinal width direction of the heat sink 3.

[0010] As illustrated in FIG. 1, the electronic device 1 is configured as a fanless industrial computer and includes a housing 2 and the electronic device unit 10 described later (see FIG. 2). The electronic device 1 is not limited to this example and may be configured as an electronic device 1 of various types, such as a desktop personal computer, a video display device, a television receiver, a game machine, and an information storage device.

[0011] The housing 2 is formed in a rectangular parallelepiped box shape shorter in the Y direction. The housing 2 is provided with plural walls including a bottom wall 2a, a top wall 2b, a front wall 2c, a left wall 2d, a rear wall 2e, and a right wall 2f. The bottom wall 2a is also referred to as, for example, a lower wall, and the top wall 2b is also referred to as, for example, an upper wall. The front wall 2c, the left wall 2d, the rear wall 2e, and the right wall 2f are each also referred to as, for example, a side wall or a peripheral wall.

[0012] The bottom wall 2a and the top wall 2b both extend in a direction (XY plane) orthogonal to the Z direction, and are spaced out in the Z direction in parallel with each other. The bottom wall 2a constitutes a lower end of the housing 2, and the top wall 2b constitutes an upper end of the housing 2. The bottom wall 2a includes plural rubber legs 2h protruding in the opposite direction to the Z direction to support the housing 2 at

a distance from a not-illustrated installation surface of a shelf, a desk, a table, or the like.

[0013] The left wall 2d and the right wall 2f both extend in a direction (XZ plane) orthogonal to the Y direction, and are spaced out in the Y direction in parallel with each other. The left wall 2d extends between the respective ends of the bottom wall 2a and the top wall 2b in the Y direction, and the right wall 2f extends between the respective ends of the bottom wall 2a and the top wall 2b in the opposite direction to the Y direction. The left wall 2d constitutes a left end of the housing 2, and the right wall 2f constitutes a right end of the housing 2.

[0014] The left wall 2d may be provided with the rubber legs 2h (see FIG. 4) protruding in the Y direction. In the present embodiment, the electronic device 1 is configured to be usable in a perpendicular posture that the rubber legs 2h on the bottom wall 2a are in contact with the installation surface and a horizontal posture that the rubber legs 2h on the left wall 2d are in contact with the installation surface. The rubber legs 2h may be attached to the housing 2 in a removable manner. The rubber legs 2h for either one of the postures may be removed when the other posture is applied.

[0015] The right wall 2f is placed to face the heat sink 3 described later which is housed in the housing 2. In the present embodiment, the right wall 2f is coupled to bosses 3d of the heat sink 3 by plural fasteners 18 such as bolts or screws penetrating in the Y direction. The right wall 2f is an example of the outer wall. As illustrated in FIG. 1, in the present embodiment, the right wall 2f and the heat sink 3 are fixed at three points by the fasteners 18. However, the number of fasteners 18 (bosses 3d) is not limited to this example and may be one, two, or four or more.

[0016] The front wall 2c and the rear wall 2e both extend in a direction (YZ plane) orthogonal to the X direction, and are spaced out in the X direction in parallel with each other. The front wall 2c extends between the respective ends of the bottom wall 2a and the top wall 2b in the X direction, and the rear wall 2e extends between the respective ends of the bottom wall 2a and the top wall 2b in the opposite direction to the X

direction. The front wall 2c constitutes the front end of the housing 2, and the rear wall 2e constitutes the rear end of the housing 2. On the front wall 2c, an auxiliary storage device 13, a power button 14, various connectors 15, and the like are provided.

[0017] The bottom wall 2a, the top wall 2b, the left wall 2d, and the right wall 2f are each provided with vent holes 2s. The vent holes 2s serve as a group of small holes penetrating each of the walls. In the present embodiment, the vent holes 2s provided at the bottom wall 2a, the top wall 2b, the left wall 2d, and the right wall 2f enable a heating part in the housing 2 to be cooled by convection of the air in each of the perpendicular posture and the horizontal posture described above.

[0018] The housing 2 is constituted by a combination of plural parts (segments) including a base cover 21, a top cover 23, a right cover 24, a bottom cover 25, and a middle frame 22 described later (see FIG. 2). The base cover 21, the top cover 23, the right cover 24, the bottom cover 25, and the middle frame 22 are formed of a metal material such as aluminum.

[0019] The base cover 21 includes a part of the bottom wall 2a, the front wall 2c, and the left wall 2d. The top cover 23 includes the respective parts (upper portions) of the top wall 2b, the left wall 2d, the rear wall 2e, and the right wall 2f. The right cover 24 includes a part (central portion) of the right wall 2f and the rear wall 2e. The bottom cover 25 includes a part (lower portion) of the right wall 2f and a part of the bottom wall 2a. The base cover 21, the top cover 23, the right cover 24, and the bottom cover 25 are coupled to each other (integrated) by fasteners 20 such as screws.

[0020] FIG. 2 is a perspective view of the electronic device unit 10. As illustrated in FIG. 2, the electronic device unit 10 includes the middle frame 22, the heat sink 3, a main substrate 4, plural sub-substrates 5 to 9, and a storage holder 16. In the electronic device unit 10, the heat sink 3, the main substrate 4, the sub-substrates 5 to 9, and the storage holder 16 are stacked into a block using the middle frame 22 described above as a base. The middle frame 22 is an example of the attachment base.

[0021] The middle frame 22 includes a middle wall 22a, plural studs 22d and 22e, and a protruding wall 22c described later (see FIG. 4). The middle wall 22a is placed substantially at the center of the electronic device unit 10 in the Y direction, specifically, placed between the main substrate 4 and the sub-substrate 6. The middle wall 22a extends in a direction (XZ plane) orthogonal to the Y direction and is parallel to the left wall 2d and the right wall 2f of the housing 2 described above. The middle wall 22a partitions the inside of the housing 2 into plural spaces in the Y direction. The middle wall 22a is also referred to as, for example, a partition wall or a barrier wall.

[0022] The stud 22d protrudes from the middle wall 22a in the opposite direction to the Y direction and is interposed between the middle wall 22a and the main substrate 4. In the present embodiment, the middle wall 22a is provided with the studs 22d spaced from each other. A head portion of each of the studs 22d is press-fitted in the middle wall 22a, for example, by crimping. The stud 22d is an example of the first stud.

[0023] A shaft portion of the stud 22d is provided with a female screw portion to be meshed with a male screw portion of a fastener 19. The fastener 19 is, for example, a screw or a bolt, and is coupled to the stud 22d while penetrating the heat sink 3 and the main substrate 4 in the Y direction. That is, in the present embodiment, the heat sink 3 and the main substrate 4 are jointly fastened by the fastener 19. The main substrate 4 is supported by the studs 22d in parallel with the middle wall 22a at a distance from the middle wall 22a in the opposite direction to the Y direction.

[0024] The stud 22e protrudes from the middle wall 22a in the Y direction, and is interposed between the middle wall 22a and the sub-substrate 6. In the present embodiment, the middle wall 22a includes the studs 22e being spaced from each other. The studs 22e are displaced from the studs 22d when viewed in the Y direction. A head portion of each of the studs 22e is press-fitted in the middle wall 22a, for example, by crimping. The stud 22e is an example of the second stud.

[0025] A shaft portion of the stud 22e is provided with a female screw portion to be meshed with a male screw portion of the fastener 19 (see FIG. 4). The fastener 19 is,

for example, a screw or a bolt, and is coupled to the stud 22e while penetrating at least the sub-substrate 6 in the Y direction. The sub-substrate 6 is supported by the studs 22e in parallel with the middle wall 22a at a distance from the middle wall 22a in the Y direction. The fastener 19 is not limited to this example, and may jointly fasten the sub-substrate 6 and the storage holder 16.

[0026] As illustrated in FIG. 2, the sub-substrate 5 is housed in an opening 22b of the middle frame 22. The sub-substrate 5 extends in parallel with the middle frame 22, and is coupled to the middle frame 22 by a fastener such as a screw and a bolt. On the sub-substrate 5, plural electronic components, a connector 15, and the like are provided. The sub-substrate 5 is also referred to as, for example, a DIO board or an extension board.

[0027] The main substrate 4 is placed in the opposite direction to the Y direction from the middle frame 22. The main substrate 4 extends in parallel with the middle frame 22 and is mechanically connected to the middle frame 22 by the studs 22d and the fasteners 19 described above. In the present embodiment, the fasteners 19 and the studs 22d are fastened, and thereby the ground pattern of the main substrate 4 is also electrically connected to the middle frame 22 and the heat sink 3.

[0028] On the main substrate 4A, plural electronic components such as a central processing unit 11 (see FIG. 4) and a main storage device 12 (see FIG. 4) described later are mounted. The wiring and those electronic components on the main substrate 4 constitute at least a part of a control circuit of the electronic device 1. The main substrate 4 is an example of the first substrate.

[0029] The sub-substrate 6 is placed in the Y direction from the middle frame 22. The sub-substrate 6 extends in parallel with the middle frame 22, and is mechanically connected to the middle frame 22 by the studs 22e and the fasteners 19. In the present embodiment, the fasteners 19 and the studs 22e are fastened, and thereby the ground pattern of the sub-substrate 6 is also electrically connected to the middle frame 22. On the sub-substrate 6, plural electronic components, a connector 15, and the like are

provided. The sub-substrate 6 is an example of the second substrate and is also referred to as, for example, an IO board or an extension board.

[0030] As illustrated in FIG. 2, the sub-substrate 7 is placed in the opposite direction to the X direction from the middle frame 22. The sub-substrate 7 extends perpendicularly to the middle frame 22 and in parallel with the rear wall 2e of the housing 2. The sub-substrate 7 is mechanically connected to the middle frame 22 by a structure similar to the studs 22d and 22e and the fasteners 19. That is, a not-illustrated standing wall extending in the Y direction is provided at an end of the middle frame 22 in the opposite direction to the X direction, and studs protrude from the standing wall toward the sub-substrate 7.

[0031] In the present embodiment, the fasteners and the studs are fastened, and thereby the ground pattern of the sub-substrate 7 is also electrically connected to the middle frame 22. On the sub-substrate 7, plural electronic components, connectors 7a, and the like (see FIG. 5) are provided. The sub-substrate 6, the main substrate 4, and the like are inserted in the connectors 7a. The sub-substrate 7 is also referred to as, for example, a back plate board, a rear board, or an extension board.

[0032] As illustrated in FIG. 2, the sub-substrate 8 is placed in the Y direction from the sub-substrate 6 and in the opposite direction to the Z direction from the auxiliary storage device 13. The sub-substrate 8 extends in parallel with the sub-substrate 6 and the middle frame 22, and is supported on a bottom wall 16a of the storage holder 16 described later. On the sub-substrate 8, plural electronic components, a power supply circuit, and the like are provided. The sub-substrate 8 is also referred to as, for example, a power supply board.

[0033] The sub-substrate 9 is placed in the opposite direction to the Z direction from the middle frame 22. The sub-substrate 9 extends perpendicularly to the middle frame 22 and in parallel with the bottom wall 2a of the housing 2 described above. On the sub-substrate 9, plural electronic components and the like are mounted. The sub-substrate 9

is inserted into a connector 6a (see FIG. 4) of the sub-substrate 6. The sub-substrate 9 is also referred to as, for example, a PCI board or an extension board.

[0034] The storage holder 16 is placed in the Y direction from the sub-substrate 6 and constitutes an end of the electronic device unit 10 in the Y direction. The storage holder 16 supports the sub-substrate 8 and the auxiliary storage device 13. The auxiliary storage device 13 is, for example, a solid state drive (SSD) or a hard disk drive (HDD).

[0035] The heat sink 3 is placed in the opposite direction to the Y direction from the main substrate 4, and constitutes an end of the electronic device unit 10 in the opposite direction to the Y direction. The heat sink 3 includes a base plate 3a, plural fins 3b, and the bosses 3d. The fins 3b protrude from the base plate 3a in the opposite direction to the Y direction, and are aligned to be spaced out in the X direction. In the present embodiment, the Y direction is an example of the first direction, and the X direction is an example of the second direction. The heat sink 3 is formed of a metal material such as aluminum.

[0036] The base plate 3a extends in parallel with the main substrate 4. In the present embodiment, the size of the base plate 3a is substantially the same as the size of the main substrate 4. The base plate 3a includes a back surface 3a2 (see FIG. 3) that is directed to the Y direction and faces the main substrate 4, and a front surface 3a1 (see FIG. 2) that is directed to the opposite direction to the Y direction and faces the right wall 2f of the housing 2. On the front surface 3a1, the fins 3b, the bosses 3d, and the like are provided. The fins 3b are an example of the first fins and also referred to as, for example, a heat radiator.

[0037] The bosses 3d protrude from the base plate 3a more than the fins 3b in the opposite direction to the Y direction. Each of the bosses 3d is provided with a female screw portion to be meshed with a male screw portion of the fastener 18 described above. The fastener 18 is, for example, a screw or a bolt, and is coupled to the boss 3d in a state of penetrating the right wall 2f of the housing 2 in the Y direction. The boss 3d is an example of the first boss.

[0038] FIG. 3 is a perspective view from the back surface 3a2 side of the heat sink 3. As illustrated in FIG. 3, the heat sink 3 also includes a protrusion 3c, bosses 3e and 3g, and fins 3f.

[0039] The protrusion 3c protrudes from the base plate 3a in the Y direction. The protrusion 3c includes a distal end surface 3c1 in the Y direction and a side surface 3c2 extending between the distal end surface 3c1 and the back surface 3a2. The distal end surface 3c1 faces the central processing unit 11 (see FIG. 4) mounted on the main substrate 4. In other words, the protrusion 3c protrudes from the base plate 3a toward the central processing unit 11. The size of the distal end surface 3c1 is substantially the same as the size of the surface of the central processing unit 11.

[0040] In the present embodiment, the distal end surface 3c1 and the central processing unit 11 are thermally connected through, for example, heat conductive grease. The distal end surface 3c1 is also referred to as, for example, a top face or a heat transfer surface. The distal end surface 3c1 is not limited to this example, and may be provided in direct contact with the central processing unit 11. The central processing unit 11 is an example of the first heating element.

[0041] The side surface 3c2 faces a space between the main substrate 4 and the base plate 3a. In the present embodiment, the side surface 3c2 is inclined toward the center of the distal end surface 3c1 as the distance from the back surface 3a2 in the Y direction increases. In other words, the protrusion 3c has a substantially trapezoidal shape in section. With the side surface 3c2 of the protrusion 3c, the formability by a draft angle of a mold is enhanced, and the surface area of the protrusion 3c is increased.

[0042] Each of the bosses 3g protrudes from the base plate 3a in the Y direction. In the present embodiment, the bosses 3g are provided adjacent to two corners on a diagonal line of the protrusion 3c. Fasteners such as screws or bolts for coupling the heat sink 3 and the main substrate 4 are attached to the bosses 3g.

[0043] The heat sink 3 is screwed nearer to the protrusion 3c by the bosses 3g, and thereby reduction in heat transfer characteristics due to separation between the

protrusion 3c and the central processing unit 11 in the Y direction is suppressed. The height in the Y direction of the bosses 3g is lower than the height in the Y direction of the protrusion 3c and the bosses 3e.

[0044] Each of the bosses 3e protrudes from the base plate 3a in the Y direction and is interposed between the base plate 3a and the main substrate 4. When viewed in the Y direction, the boss 3e is placed to overlap with the stud 22d described above (see FIG. 4). That is, the fastener 19 for jointly fastening the heat sink 3 and the main substrate 4 is attached to the boss 3e. The bosses 3e and 3g are an example of the second boss.

[0045] The fins 3f each protrude from the base plate 3a in the Y direction, and are aligned to be spaced out in the X direction. The fins 3f face a space between the main substrate 4 and the base plate 3a. The height in the Y direction of the fins 3f is smaller than the height in the Y direction of the protrusion 3c.

[0046] In the present embodiment, with such fins 3f, the surface area of the heat sink 3 is increased and the back surface 3a2 of the base plate 3a is reinforced. The fins 3b are an example of the second fins and also referred to as, for example, a heat radiator or beads.

[0047] FIG. 4 is a YZ sectional view of the electronic device 1 in FIG. 1. As illustrated in FIG. 4, the middle frame 22 includes the protruding wall 22c. The protruding wall 22c protrudes from the middle wall 22a in the opposite direction to the Y direction, and is bent so as to extend along the main substrate 4 at a position away from the middle wall 22a.

[0048] The protruding wall 22c faces the main storage device 12 mounted on the main substrate 4. In other words, the protruding wall 22c protrudes from the middle wall 22a toward the main storage device 12. The protruding wall 22c is coupled to the middle wall 22a by fasteners 22f such as screws or bolts. The middle wall 22a is also referred to as, for example, a first metal sheet, and the protruding wall 22c is also referred to as, for example, a second metal sheet.

[0049] In the present embodiment, the protruding wall 22c and the main storage device 12 are thermally connected through a heat conducting member 30. With this configuration, it is possible to transfer the heat from the main storage device 12 toward the middle frame 22 by thermal diffusion through the heat conducting member 30. The main storage device 12 is an example of the second heating element. The main storage device 12 is mounted on a surface of the main substrate 4 on a side opposite to the central processing unit 11 and displaced from the central processing unit 11 when viewed in the Y direction.

[0050] The heat conducting member 30 includes a grease 31 and a sheet 32. The grease 31 is applied on an end surface of the protruding wall 22c in the opposite direction to the Y direction. The grease 31 is a heat conductive grease, and contains a conductive material.

[0051] The sheet 32 extends along the main substrate 4, and is interposed between the grease 31 and the main storage device 12. The sheet 32 is a thermal sheet, and has heat conductivity and insulating properties. In the present embodiment, such a sheet 32 is sandwiched between the main storage device 12 and the grease 31, thereby the grease 31 is prevented from coming into contact with and being electrically connected to a terminal of the main storage device 12, a terminal of the main substrate 4, or the like.

[0052] The storage holder 16 includes the bottom wall 16a supporting the auxiliary storage device 13, the sub-substrate 8, and the like. The bottom wall 16a extends along the middle frame 22 and covers a side surface 13a of the auxiliary storage device 13 in the opposite direction to the Y direction and a surface of the sub-substrate 8 in the opposite direction to the Y direction.

[0053] In other words, the bottom wall 16a is interposed at a position halfway on the heat transfer path from the middle frame 22 and the heating elements, such as the main storage device 12 and the central processing unit 11, toward the auxiliary storage device 13 and the sub-substrate 8. The storage holder 16 is made of a heat insulating material

such as a synthetic resin. The bottom wall 16a is an example of the heat insulating wall, and the side surface 13a is an example of the second surface.

[0054] FIG. 5 is an XY sectional view of the electronic device 1 in FIG. 1. As illustrated in FIG. 5, the heat sink 3 is provided with a concavity 3h corresponding to the protrusion 3c. The concavity 3h is concave in the Y direction from the front surface 3a1 located at a side of the protrusion 3c opposite to the central processing unit 11, that is, located in the opposite direction to the Y direction from the protrusion 3c. The front surface 3a1 is an example of the first surface.

[0055] The fins 3b include plural fins 3b1 and plural fins 3b2. The fins 3b1 extend in the opposite direction to the Y direction from the front surface 3a1, and the fins 3b2 extend in the opposite direction to the Y direction from a bottom portion 3h1 of the concavity 3h. In the present embodiment, the length in the Y direction of the fins 3b1 is substantially the same as the length in the Y direction of the fins 3b2. Therefore, at the distal ends of the fins 3b, a concavity being concave in the Y direction is formed by the fins 3b2.

[0056] In the present embodiment with such a configuration, the fins 3b2 overlapping with the central processing unit 11 in the Y direction are arranged at a farther distance from the right wall 2f of the housing 2. This configuration can prevent the temperature of the right wall 2f from being locally increased due to heat radiation (radiation) from the fins 3b2 that tend to become hotter than the fins 3b1 among the fins 3b.

[0057] In the present embodiment, at least part of the fins 3b2 are covered, from the opposite direction to the Y direction, with a portion of the right wall 2f where the vent holes 2s are not provided (see FIG. 1). With this configuration, the flow rate of the air flowing through the vicinity of the fins 3b2 is increased. The present embodiment thus can enhance the cooling effect (heat dissipation effect) by the air in the neighborhood of the fins 3b2 that tend to be at the highest temperature in the heat sink 3.

[0058] An exemplary assembly method of the electronic device 1 will be described.

First of all, the sub-substrate 5, the main substrate 4, and the heat sink 3 are assembled

in this order on one side of the middle frame 22 in the opposite direction to the Y direction (S1). S1 is an example of the first step.

[0059] Next, the middle frame 22 is turned upside down, and the sub-substrate 7 is assembled perpendicularly to the middle frame 22 (S2). S2 is an example of the second step.

[0060] Next, the sub-substrate 6 and the storage holder 16 are assembled in this order on the other side of the middle frame 22 in the Y direction, and the sub-substrates 8 and 9 are assembled to construct the electronic device unit 10 (S3). S3 is an example of the third step.

[0061] Next, the electronic device unit 10 is assembled to the base cover 21 of the housing 2 (S4). Then, the top cover 23, the right cover 24, and the bottom cover 25 are assembled to construct the electronic device 1 (S5). S4 is an example of the fourth step, and S5 is an example of the fifth step.

[0062] As described above, in the present embodiment, the heat sink 3 includes the base plate 3a, the protrusion 3c protruding from the base plate 3a in the Y direction (first direction) and thermally connectable to the central processing unit 11 (first heating element) mounted on the main substrate 4 (first substrate), the fins 3b (first fins) protruding from the base plate 3a in the opposite direction to the Y direction and aligned in the X direction (second direction), the boss 3d (first boss) protruding from the base plate 3a more than the fins 3b in the opposite direction to the Y direction and to which the fastener 18 for coupling the right wall 2f (outer wall) of the housing 2 and the base plate 3a is attachable, and the boss 3e (second boss) protruding from the base plate 3a in the Y direction and to which the fastener 19 for coupling the main substrate 4 and the base plate 3a is attachable.

[0063] With such a configuration, the protrusion 3c enables avoidance of interference between the base plate 3a and a component other than the central processing unit 11 mounted on the main substrate 4, so that the base plate 3a and thus the heat sink 3 can be made larger in a size to be equivalent to the main substrate 4. As a result, the surface

area of the heat sink 3 can be increased and consequently, the temperature increase of the central processing unit 11 can be suppressed more effectively even in a fanless electronic device 1. Moreover, the heat sink 3 can be fixed to the housing 2 and the main substrate 4 by the bosses 3d and 3e protruding from the base plate 3a and the fasteners 18 and 19, so that even a relatively large heat sink 3 can be held more reliably or more firmly. In addition, the fastening between the fasteners 18 and 19 and the bosses 3d and 3e can also be used to electrically connect the ground pattern of the main substrate 4 to the heat sink 3 and thus the housing 2. Thus, the housing 2 functions as the heat sink 3 and the ground member of the main substrate 4 and therefore can cope with electromagnetic interference (EMI).

[0064] In the present embodiment, the protrusion 3c is provided with the concavity 3h that is concave in the Y direction from the front surface 3a1 (first surface) on the side opposite to the central processing unit 11, and the fins 3b2 being part of the fins 3b protrude from the bottom portion 3h1 of the concavity 3h in the opposite direction to the Y direction.

[0065] With such a configuration, when the fins 3b are formed with substantially the same length in the Y direction, the fins 3b2 protruding from the bottom portion 3h1 of the concavity 3h can be arranged at a farther distance from the right wall 2f of the housing 2. This configuration can prevent the temperature of the right wall 2f from being locally increased due to heat radiation (radiation) from the fins 3b2 that tend to become hotter than the fins 3b1 among the fins 3b. Supposing that the fins 3b are formed such that the distal ends thereof in the opposite direction to the Y direction are aligned, the length of the fins 3b2 can be made longer than the length of the fins 3b1. This configuration can further increase the surface area of the heat sink 3 and thus may further enhance the effect of cooling the central processing unit 11 (heat radiation effect).

[0066] In the present embodiment, the heat sink 3 includes the fins 3f (second fins) protruding from the base plate 3a in the Y direction and aligned in the X direction.

[0067] With this configuration, the fins 3f enables increase in the surface area of the heat sink 3, thereby further enhancing the effect of cooling the central processing unit 11 (heat dissipation effect). Moreover, the fins 3f enables reinforcement of the back surface 3a2 of the base plate 3a on the side opposite to the fins 3b, and thus can suppress deformation of the base plate 3a toward the fins 3b due to heat shrinkage.

[0068] In the present embodiment, the electronic device unit 10 is configured to be attachable to the housing 2 in a state where the heat sink 3, the main substrate 4 on which the central processing unit 11 is mounted to be thermally connected to the protrusion 3c of the heat sink 3, the middle frame 22 (attachment base) placed on the side opposite to the heat sink 3 in the Y direction from the main substrate 4, the sub-substrate 6 (second substrate) placed in the Y direction from the middle frame 22, and the storage holder 16 placed in the Y direction from the sub-substrate 6 to hold the auxiliary storage device 13, are integrated.

[0069] With such a configuration, the electronic device unit 10 formed in a block can reduce the time and effort taken to manufacture the electronic device 1 (assembly operation) and can make the electronic device 1 more compact, compared with the case when the heat sink 3, the main substrate 4, the middle frame 22, the sub-substrate 6, and the storage holder 16 are individually assembled to the housing 2.

[0070] In the present embodiment, the middle frame 22 includes the middle wall 22a placed between the main substrate 4 and the sub-substrate 6, the stud 22d (first stud) protruding from the middle wall 22a in the opposite direction to the Y direction and to which the fastener 19 for coupling the main substrate 4 and the middle frame 22 is attachable, and the stud 22e (second stud) protruding from the middle wall 22a in the Y direction and to which the fastener 19 for coupling the sub-substrate 6 and the middle frame 22 is attachable.

[0071] With such a configuration, the main substrate 4 and the sub-substrate 6 can be fixed to the middle frame 22 relatively easily by the studs 22d and 22e protruding from the middle wall 22a and the fasteners 19. Furthermore, the fastening between the

fasteners 19 and the studs 22d and 22e can also be used to electrically connect the ground pattern of the main substrate 4 and the ground pattern of the sub-substrate 6 to the middle frame 22. Thus, the middle frame 22 functions as the ground member of the main substrate 4 and the sub-substrate 6 and therefore can cope with electromagnetic interference (EMI).

[0072] In the present embodiment, the main storage device 12 (second heating element) is mounted on the main substrate 4 and provided in a state of being thermally connected to the middle frame 22 through the heat conducting member 30. The heat conducting member 30 includes the grease 31 applied on the middle frame 22 and the sheet 32 interposed between the grease 31 and the main storage device 12.

[0073] With such a configuration, it is possible to transfer the heat from the main storage device 12 toward the middle frame 22 by thermal diffusion through the heat conducting member 30, thereby suppressing temperature increase of the main storage device 12 more effectively. Moreover, the sheet 32 interposed between the grease 31 and the main storage device 12 can prevent the grease 31 from coming into contact with and being electrically connected to a terminal of the main storage device 12, a terminal of the main substrate 4, and the like.

[0074] In the present embodiment, the storage holder 16 includes the bottom wall 16a (the heat insulating wall) at least covering the side surface 13a (second surface) of the auxiliary storage device 13 located in the opposite direction to the Y direction.

[0075] With such a configuration, the heat transferred from the middle frame 22, the main storage device 12, and the central processing unit 11 toward the auxiliary storage device 13 is suppressed by the bottom wall 16a, so that increase in temperature of the auxiliary storage device 13 can be suppressed.

[0076] Although embodiments of the present invention have been described above, the foregoing embodiments are illustrated by way of example and are not intended to limit the scope of the invention. The foregoing embodiments can be carried out in other various modes, and a variety of elimination, replacement, combination, and

modifications can be made without departing from the scope of the invention. The configurations and the specifications such as shape (including structure, kind, direction, form, size, length, width, thickness, height, number, arrangement, position, and material) can be modified and implemented as appropriate.

CLAIMS

1. An electronic device unit comprising:
a heat sink including:
 - 5 a base plate;
a protrusion protruding from the base plate in a first direction intersecting the base plate, the protrusion being thermally connectable to a first heating element mounted on a first substrate;
a plurality of first fins protruding from the base plate in an opposite
10 direction to the first direction, the plurality of first fins being aligned in a second direction intersecting the first direction;
a first boss protruding from the base plate more than the plurality of first fins in the opposite direction to the first direction, the first boss allowing a fastener to be attached to the first boss, the fastener serving to couple an outer
15 wall of a housing and the base plate; and
a second boss protruding from the base plate in the first direction, the second boss allowing a fastener to be attached to the second boss, the fastener serving to couple the first substrate and the base plate;
the first substrate on which the first heating element is mounted in a state where
20 the first heating element is thermally connected to the protrusion of the heat sink;
an attachment base being placed on a side opposite to the heat sink in the first direction from the first substrate;

a second substrate being placed in the first direction from the attachment base;
and

a storage holder being placed in the first direction from the second substrate to hold an auxiliary storage device, wherein

5 the electronic device unit is configured to be attachable to the housing in a state where the heat sink, the first substrate, the attachment base, the second substrate, and the storage holder are integrated with one another, and

the attachment base includes

10 a middle wall being placed between the first substrate and the second substrate,

a first stud protruding from the middle wall in the opposite direction to the first direction, the first stud allowing a fastener to be attached to the first stud, the fastener serving to couple the first substrate and the attachment base, and

15 a second stud protruding from the middle wall in the first direction, the second stud allowing a fastener to be attached to the second stud, the fastener serving to couple the second substrate and the attachment base.

2. The electronic device unit according to claim 1, wherein

20 the protrusion includes a concavity being concave in the first direction from a first surface on a side opposite to the first heating element, and

part of the plurality of first fins protrudes from a bottom portion of the concavity in the opposite direction to the first direction.

3. The electronic device unit according to claim 1 or 2, further comprising a plurality of second fins protruding from the base plate in the first direction, the plurality of second fins being aligned in the second direction.

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4. The electronic device unit according to claim 1, further comprising a second heating element being mounted on the first substrate, the second heating element being provided in a state where the second heating element is thermally connected to the attachment base through a heat conducting member,

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wherein the heat conducting member includes

a grease being applied on the attachment base, and

a sheet being interposed between the grease and the second heating element.

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5. The electronic device unit according to claim 4, wherein the storage holder includes a heat insulating wall covering at least a second surface of the auxiliary storage device, the second surface being located in the opposite direction to the first direction.