

ELECTRONIC DEVICE COOLING MODULE

Field of the Disclosure

5 [001] The present disclosure relates to a cooling system and in particular, a cooling system for electronic devices and boards. The cooling system may provide a container for enclosing heat generating components such as motherboards, memory modules or servers that require active or fluid cooling, and a reservoir for liquid coolant. The cooling system may further provide a heating element to heat the liquid coolant.

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Background of the Disclosure

[002] Many types of electrical component generate heat during operation. In particular, electrical computer components such as motherboards, central processing units (CPUs) and memory modules may dissipate substantial amounts of heat when in use. Heating of the electrical components to high temperatures can cause damage, affect performance or cause a safety hazard. Accordingly, substantial efforts have been undertaken to find efficient, high performance systems for cooling electrical components effectively and safely.

15 [003] One type of cooling system uses liquid cooling. Although different liquid cooling assemblies have been demonstrated, in general the electrical components are immersed in a coolant liquid, so as to provide a large surface area for heat exchange between the heat generating electrical components and the coolant.

[004] An example of a conventional cooling system in which heat generating electronic components are immersed in liquid coolant can be found in WO-A-2018/096362.

25 [005] In the electronic device cooling modules described above, the cooling methods all rely on liquid coolant being pumped around cooling system. However, in some situations it is desirable or necessary to position the cooling systems in a wide range of temperatures, including very cold temperatures. In some applications, the temperature can be as low as -40°C. This can make operation of the electronic device more difficult.

30 [006] Consequently, allowing computer systems to work in very low temperatures is desirable.

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Summary of the Invention

[007] Against this background, there is generally provided an electronic device cooling module that provides liquid cooling to components within the module housing at a wide range of external temperatures, particularly extreme cold. There is also provided a method for ensuring that liquid coolant can still provide effective cooling of electronic components at cold ambient temperatures.

[008] In a first aspect, there is provided an electronic device cooling module in accordance with claim 1. Further features of this aspect are detailed in the dependent claims and herein.

[009] An electronic device cooling module comprises a container enclosing at least one first electronic device and a liquid coolant reservoir. A pump is located within the liquid coolant reservoir and is arranged to pump liquid coolant from the liquid coolant reservoir to the first electronic device via a liquid coolant conduit, providing cooling of the at least one first electronic device. The liquid coolant reservoir also includes a heating element communicably coupled to a controller, and the controller is communicably coupled to a temperature sensor that is disposed within the liquid coolant reservoir.

[010] Very low temperatures can cause the liquid coolant used in such systems (for example, a dielectric liquid) to increase in viscosity, potentially becoming difficult or impossible to pump. If coolant cannot be effectively pumped to the electronic components, the performance of the devices can be reduced, and the devices may fail.

[011] Advantageously, this arrangement allows the cooling module to be placed in an environment with a very low ambient temperature because the liquid coolant can be heated to a temperature where it is no longer too viscous to pump to the electronic devices. This further allows the computing equipment contained within the electronic device cooling module to be turned on and off without risk of damage due to inadequate cooling.

[012] In some embodiments, the container may include a coolant manifold (alternatively termed a coolant distribution manifold) which is configured to receive liquid coolant from the liquid coolant reservoir via the pump. The coolant manifold may be arranged to distribute liquid coolant to a plurality of first electronic devices disposed within the container, wherein each electronic device is connected to the coolant manifold by a respective liquid coolant conduit. This advantageously allows more than one first electronic device to be efficiently cooled using the same pump and liquid coolant reservoir.

[013] Optionally, the pump may be communicably coupled to the controller. This advantageously allows the controller to start pumping coolant when the coolant is liquid

enough to be effectively pumped. It further allows the controller to prevent the pumping of coolant when it is too viscous to be effectively pumped, preventing damage to the cooling equipment.

5 [014] In some embodiments, the or each first electronic device may be thermally coupled to a respective cooling block assembly. The cooling block assembly may be in liquid communication with the or each liquid coolant conduit. Optionally, the cooling block assembly may be configured to receive liquid coolant from a respective liquid coolant conduit. This provides the benefit of allowing improved cooling of the first electronic device by delivering coolant to a dedicated cooling block assembly (such as a heatsink, for
10 example), which can effectively transfer heat from the first electronic device to the liquid coolant, allowing the removal of heat.

[015] In some embodiments, the or each cooling block assembly may be configured to allow overflow of liquid coolant from within the cooling block assembly into the interior of the container. This advantageously allows the liquid coolant to flow back to the source
15 liquid coolant reservoir along the base of the container, thus removing the need for a separate return conduit, which would add to the complexity and expense of the system.

[016] Optionally, the overflow of liquid coolant from the or each cooling block assembly may be directed to least one proximal second electronic device. This advantageously allows for electronic devices other than just the first electronic device to be cooled without
20 requiring further conduits to direct the coolant to them. This is especially useful where the second electronic device does not require the same extent of cooling as the first electronic device, and the liquid coolant does not need to be as cold as when cooling the first electronic device.

[017] Optionally, the overflow of liquid from the or each cooling block assembly may be
25 directed to the at least one proximal second electronic device via a multi-orifice distribution tray. This beneficially allows better distribution of the liquid coolant to the second electronic device, allowing more effective cooling of the second electronic device as the liquid coolant can be directed directly to the at least one second electronic device.

[018] Optionally, the multi-orifice distribution tray may be in direct liquid contact with a
30 respective cooling block assembly. This advantageously allows more effective cooling of the at least one second electronic device as the liquid coolant can directly remove the heat from the second electronic device.

[019] In some embodiments, the first electronic device may be a central processing unit (CPU) or graphics processing unit (GPU). This is beneficial as these components are
35 commonly found in computer systems, and often generate the most heat.

[020] In some embodiments, the at least one proximal second electronic device may be a dual in-line memory module (DIMM). This is beneficial as these components are commonly found in computer systems, and are often located close to the CPUs or GPUs for operational reasons. Furthermore, DIMMs generally generate less heat than CPUs or GPUs.

[021] In some embodiments, the cooling block assembly may be a heatsink or a coolant cold plate device. These assemblies advantageously provide effective cooling, allowing better removal of heat from the first electronic device.

[022] In some embodiments, the container may include a base arranged to urge liquid coolant within the container to flow towards the liquid coolant reservoir. This advantageously allows the liquid coolant to flow back to the source liquid coolant reservoir along the base of the container, thus removing the need for a separate return conduit, which would add to the complexity and expense of the system.

[023] Optionally, the liquid coolant reservoir is a sump formed in the base of the container. This advantageously allows gravity to be used to return the liquid coolant to the reservoir, avoiding the need for additional pumps.

[024] In some embodiments, the controller may be configured to receive an indication of the temperature of the liquid coolant within the liquid coolant reservoir from the temperature sensor, and to control the heating element based on the received indication of the temperature. This advantageously allows the heating element to be controlled as a direct result of the temperature of the coolant. Consequently, the coolant temperature will not drop below a predetermined temperature during operation.

[025] In some embodiments, the controller may be configured to activate the heating element if the received indication of the temperature is at or below a predetermined activation temperature, and deactivate the heating element when the liquid coolant is at or above a predetermined deactivation temperature. By having different threshold temperatures for activating and deactivation the heating element, the coolant temperature can be kept within a certain range where, for example, it is fluid enough to be effectively pumped, but cool enough to sufficiently cool the at least one electronic device. It furthermore allows for hysteresis to be used, prevent excessive switching of power to the heating element.

[026] In some further embodiments, the controller may be further configured to activate the pump to direct liquid coolant from the liquid coolant reservoir to the at least one electronic device if the received indication of the temperature is at least at a predetermined pumping temperature. This advantageously allows pumping of the coolant to be delayed

until the coolant is at a high enough temperature to be fluid enough to be pumped effectively and without damage to the pump or other equipment.

[027] In a second aspect, there is provided a method for cooling an electronic device in accordance with claim 14. Further features of this aspect are detailed in the dependent
5 claims and herein. This aspect can be combined with the first aspect and/or any optional features of the first aspect as disclosed herein.

[028] A method is provided for cooling an electronic device enclosed within an electronic device cooling module, the electronic device cooling module including a container enclosing at least one first electronic device and a liquid coolant reservoir. The method
10 comprises the steps of:

monitoring a temperature of liquid coolant within the liquid coolant reservoir via a temperature sensor disposed within the liquid coolant reservoir;

activating a heating element within the liquid coolant reservoir if the temperature of the liquid coolant is below a predetermined activation temperature,
15 and deactivating the heating element when the liquid coolant is at or above a predetermined deactivation temperature;

activating a pump located within the liquid coolant reservoir to direct liquid coolant from the liquid coolant reservoir to the at least one electronic device if the temperature of the liquid coolant is at least at a predetermined pumping
20 temperature;

providing cooling of the at least one electronic device with liquid coolant received from the liquid coolant reservoir via a liquid coolant conduit.

[029] Advantageously, this method allows the cooling module to be placed in an environment with a very low ambient temperature because the liquid coolant can be heated
25 to a temperature where it is no longer too viscous to pump to the electronic devices. This further allows the computing equipment contained within the electronic device cooling module to be turned on and off without risk of damage due to inadequate cooling.

[030] In some embodiments, one or more of the temperature monitoring; heating element activation; heating element deactivation; pump activation; and pump deactivation may be
30 controlled via a controller device disposed within the electronic device cooling module. This advantageously allows precise control of the temperature and/or flow of the coolant, ensuring that coolant of the incorrect temperature is not attempted to be pumped around the system, which could cause damage to components of the electronic device cooling module.

[031] In some embodiments, the liquid coolant received by the at least one first electronic device is, subsequent to cooling said at least one first electronic device, directed to at least one proximal second electronic device. This advantageously allows for electronic devices other than just the first electronic device to be cooled without requiring further conduits to
5 direct the coolant to them. This is especially useful where the second electronic device does not require the same extent of cooling as the first electronic device, and the liquid coolant does not need to be as cold as when cooling the first electronic device.

[032] In some embodiments, the liquid coolant received from the liquid coolant reservoir via the liquid coolant conduit is recycled by return to the liquid coolant reservoir under
10 gravity. This advantageously removes the need for additional conduits or pumps to return the coolant to the reservoir.

[033] In respect of any and all of the aspects disclosed herein, features of a method for manufacturing and/or operating corresponding with those of any one or more of the electronic device cooling modules disclosed may additionally be provided. Combinations of
15 aspects are also possible. Moreover, combinations of specific features from one aspect with the features of another aspect are also disclosed, where such combinations are compatible. Specific examples of such combinations are suggested herein, by way of example.

20 **Brief description of the Figures**

[034] The disclosure may be put into practice in a number of ways and preferred embodiments will now be described by way of example only and with reference to the accompanying drawings, as now described.

[035] Figure 1 shows a plan view of an embodiment of an electronic device cooling
25 module enclosing a single first electronic device.

[036] Figure 2 shows a side elevation view of the electronic device cooling module shown in Figure 1.

[037] Figure 3 shows a side elevation view of an electronic device cooling module enclosing first and second electronic devices.

30 [038] Figure 4 shows a plan view of an electronic device cooling module enclosing a plurality of first electronic devices.

[039] Figure 5 shows a side elevation view of the electronic device cooling module shown in Figure 4.

35 [040] Figure 6 shows a side elevation view of an electronic device cooling module enclosing a plurality of first and second electronic devices.

[041] Figure 7A shows a perspective view showing a prior art arrangement of cooling block arrangement and first and second electronic devices.

[042] Figure 7B shows a plan view schematic view of the prior art arrangement shown in Figure 7A.

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Detailed description of the preferred embodiments

[043] With reference to Figure 1, there is shown an electronic device cooling module in accordance with a first embodiment. The module 1 includes a container 2 which is preferably liquid-tight and more preferably a (metal) box, optionally with a removable cover (not shown). The module further comprises: pump 3; liquid coolant reservoir 4; first electronic device 5; liquid coolant conduit 6; heating element 7; controller device 8; temperature sensor 9; substrate 10; and cooling block assembly 13. The container 2 encloses a substrate or printed circuit board (PCB) 10 on which a first electronic device 5 is mounted. The PCB 10 may be a computer server motherboard, but could be any substrate on which electronic devices can be mounted. The first electronic device 10 can be any electronic component that generates heat, such as a central processing unit (CPU) or graphics processing unit (GPU). The first electronic device is surmounted by a cooling block assembly 13. The cooling block assembly 13 may be a cooling module heatsink, such as those disclosed and described in WO-A-2019/048864 or WO-A-2022/112799. In alternative arrangements the cooling block assembly 13 may be configured as a cold plate device.

[044] The container 2 further includes a liquid coolant reservoir 4 which can hold a quantity of dielectric liquid coolant. The dielectric coolant in the liquid coolant reservoir 4 can be directed by pump 3 towards the first electronic device 5 via a liquid coolant conduit 6. The arrowhead shown on the liquid coolant conduit 6 is purely symbolic, and is used to illustrate clearly the direction of coolant flow. The liquid coolant conduit 6 may be formed as a pipe or a tube, and may be rigid or flexible, depending on the requirements of the particular application.

[045] The container 2 additionally contains a heating element 7 and temperature sensor 9 located within the liquid coolant reservoir 4. A controller 8 is communicably coupled to the heating element 7, temperature sensor 8 and pump 3. The controller 8 may be coupled to the heating element 7, temperature sensor 8 and pump 3 through any known data transfer method, for example, electrically, wirelessly, optically or mechanically. The controller 8 may

be a microprocessor, a microcontroller, a field-programmable gate array, or any other such similar processing device.

[046] With reference now to Figure 2, there is shown a side elevation of the embodiment of Figure 1, it can be seen that the liquid coolant reservoir 4 is formed as a sump or recess portion in the base 19 of the container 2. The level of the liquid coolant 18 within the reservoir 4 will be determined at least partially by the physical depth of the reservoir 4.

[047] With reference to the embodiment shown in Figures 1 and 2, a typical example of operation of the electronic device cooling module 1 will be described. The temperature sensor 9 monitors the temperature of the liquid coolant within the reservoir 4 and provides a feedback signal representing or indicating the temperature of the liquid coolant in the reservoir 4 to the controller 8. If the measured temperature of the liquid coolant in the reservoir 4 is at or below a predetermined activation temperature, then the controller 8 can activate the heating element 7 to heat the liquid coolant. Additionally or alternatively, if the measured temperature of the liquid coolant in the reservoir 4 is below a predetermined pumping temperature, then the controller 8 can deactivate the pump 3 to prevent coolant pumping.

[048] When the controller 8 detects that the temperature of the liquid coolant in the reservoir 4, as measured by the temperature sensor 9, reaches or goes above a predetermined pumping temperature, the controller 8 can activate the pump 3 to effect coolant pumping. Additionally or alternatively, if the measured temperature of the liquid coolant in the reservoir 4 is at or above a predetermined deactivation temperature, then the controller 8 can deactivate the heating element 7. The deactivating of the heating element 7 may be a complete deactivation, or partial. For example, it may gradually decrease the power of the heating element 7 in order to provide a smooth operating transition of the liquid coolant being pumped within the system.

[049] The predetermined activation temperature may be equal to, or different from, the predetermined deactivation temperature. Preferably, the predetermined activation temperature may be lower than the predetermined deactivation temperature.

[050] The pumping temperature may be the same as one, both or neither of the activation temperature or the deactivation temperature. Specifically, the pumping temperature may be equal to the deactivation temperature. Alternatively, the pumping temperature may be between the activation temperature and the deactivation temperature.

[051] When the pump 3 is activated, liquid coolant is pumped from the liquid coolant reservoir 4, through the liquid coolant conduit 6 to the cooling block assembly 13. The cooling block assembly 13 then cools the first electronic device 5, for example by

distributing the liquid coolant over the first electronic device 5, allowing improved performance and extended lifetime of the first electronic device 5. After cooling, the liquid coolant flows out of the cooling block assembly 13, for example by overflowing the peripheral walls, and into the interior of the container 2. The liquid coolant then flows along the base 19 under gravity to the liquid coolant reservoir 4.

[052] With reference now to Figure 3, an alternative embodiment of the electronic device cooling module is shown. This embodiment contains all features as discussed in relation to Figures 1 and 2, but with the addition of a plurality of second electronic devices 16 positioned in proximity to the cooling block assembly 13. There is also shown the overflow 11 from the cooling block assembly 13. The second electronic devices 16 may include at least one electronic component that generates heat, and consequently requires cooling. Typically, the second electronic devices 16 will be memory modules, such as dual in-line memory module (DIMM) cards. In this embodiment, when the pump 3 is activated, the liquid coolant is pumped from the reservoir 4 via the liquid coolant conduit 6 to the cooling block assembly 13 and overflows 11 the cooling block assembly 13 to provide cooling to the second electronic devices 16. The cooling of the second electronic device 16 by the liquid coolant may be provided by direct contact between the liquid coolant and the second electronic device 16, or there may be a thermal interface (such as a heatsink) between the second electronic device 16 and the overflowed 11 liquid coolant. After cooling the second electronic device 16, the liquid coolant then flows along the base 19 under gravity to the liquid coolant reservoir 4.

[053] In some embodiments, there may be more than one first electronic device. This can be seen from Figure 4, which shows the embodiment shown in Figures 1 and 2, with the addition of a plurality of first electronic devices 5 and associated cooling block assemblies 13. The liquid coolant conduit 6 connects the pump 3 to a coolant distribution manifold 17 (alternatively termed a coolant manifold). The coolant distribution manifold 17 distributes the liquid coolant from the liquid coolant conduit 6 into a plurality of individual branch conduits 6a, 6b, 6c & 6d. The liquid coolant may be distributed evenly or unevenly between the individual branch conduits 6a, 6b, 6c & 6d, depending on the requirements of the specific implementation. In Figure 4, there are shown four individual branch conduits 6a, 6b, 6c & 6d, four first electronic devices 5 and four cooling block assemblies 13. However, there may be any number of individual branch conduits 6a, 6b, 6c & 6d, first electronic devices 5 and cooling block assemblies 13. Figure 5 shows a side view of the embodiment of Figure 4. Only two first electronic devices 5, cooling block assemblies 13 and individual branch conduits 6a & 6b are shown for clarity. The function and operation of the

embodiment shown in Figures 4 and 5 is the same as described in relation to Figures 1 and 2.

[054] With reference now to Figure 6, an embodiment is described that is combination of the embodiment shown in Figure 3 and the embodiment shown in Figures 4 and 5. Figure 6 shows the plurality of first electronic devices 5, cooling block assemblies 13 and individual branch conduits 6a & 6b shown in Figure 5, with the addition of the second electronic devices 16 shown in Figure 3. The second electronic devices 16 are positioned in proximity to the first electronic devices 5 and cooling block assemblies 13. The second electronic devices 16 are cooled by liquid coolant overflowing 11 from the cooling block assemblies 13 and directly or via a thermal interface contacting the second electronic devices 16. The coolant then flows along the base 19 of the container 2 and returns to the liquid coolant reservoir 4, allowing recycling or reuse of the liquid coolant. Each of the plurality of first electronic devices 5 may have at least one respective associated second electronic device 16 cooled in this way. Alternatively, only some of the plurality of first electronic devices 5 may have associated second electronic devices 16 cooled in this way, with the other first electronic devices 5 not having second electronic devices 16 located in proximity to them. Additionally or alternatively, some of the first electronic devices 5 may have second electronic devices 16 located in proximity to them, but which are not cooled by the liquid coolant overflowing 11 from a cooling block assembly 13.

[055] With reference now to Figure 7A and 7B, a method for directing overflow 11 liquid coolant from the cooling block assembly 13 to the second electronic devices 16 (as utilised in the embodiments shown in Figures 3 and 6) will be described. As noted above, the cooling block assembly 13 may be a heatsink 21. The heatsink 21 is positioned on the substrate or PCB 10 above a first electronic device 5. A multi-orifice distribution tray 20 is positioned on at least one of the sides of the heatsink 21 or cooling block assembly 13 so that they are in direct liquid communication, and further positioned so that it is above one or more second electronic devices 16. The multi-orifice distribution tray 20 comprises a plurality of orifices 22 that are located substantially above the one or more second electronic devices 16. Liquid coolant is delivered to the heatsink 21 from the liquid coolant reservoir 4 (not shown) via the pump 3 (not shown) in the flow direction 6'. The liquid coolant may flow directly from the pump 3 (not shown) or via a coolant distribution manifold 17 (not shown). In Figures 7A and 7B, the heatsink 21 is shown with four major sides and two multi-orifice distribution trays, however the heatsink may be any shape and have any number of sides, and there may be any number of multi-orifice distribution trays located against the edges of the heatsink 21.

[056] After liquid coolant is delivered to the heatsink 21, it overflows 11 the heatsink 21 and flows into the one or more multi-orifice distribution trays 20. The liquid coolant then flows or drips through the plurality of orifices 22 onto the one or more second electronic devices 16, providing cooling to the one or more second electronic devices 16. The liquid
5 coolant then flows along the base 19 of the container 2 under gravity to the liquid coolant reservoir 4 for reuse.

[057] Although specific embodiments have now been described, the skilled person will appreciate that various modifications and alterations are possible. The design of the container 2 may be different in shape and/or structure, from that indicated (for example, it
10 may not be cuboid). Alternative electronic devices from those shown as first electronic device 5 and/or second electronic device 16 may be used, for example having different shapes, structures or applications. In some embodiments, there may be a different design of (or indeed, no) PCB 10, or there may be any number of PCBs (including just one). Furthermore, a different type of board, such as stripboard, may be used. The layout of
15 PCBs 10, electronic devices 5, 16, and other components may be varied significantly. There are many different methods known to the skilled person for removing the heat from the liquid coolant, an of which could be employed with any embodiment of the present invention.

[058] The design and layout of the conduits 6 and coolant distribution manifold 17 may
20 vary significantly from that shown in the figures, but still carry out the same function. Furthermore, the cooling block assembly 13 and/or heatsink 21 may be varied, for example by having different sizes and/or shapes. The cooling block assembly 13 and/or heatsink 21 may be thermally coupled to a first electronic device 5. This may be achieved, for example, using thermal paste. Heatsink 21 may have any arrangement of pins, fins or other
25 structures to increase the surface area. Such fins or pins may have a different arrangement to those shown, such as different sizes and/or shapes. Heatsinks 21 may have any number of multi-orifice distribution trays 20 connected to any number of sides of the heatsink 21. Any number or combination of first 5 and second electronic devices 16 may be used, with different cooling block assemblies 13 with different numbers of sides and/or multi-orifice
30 distribution trays 20. Alternative methods of fixing the components together may be provided, such as adhesive, rivets or other attachment forms.

[059] The coolant distribution manifold 17 may alternatively be replaced with any other method of distributing liquid coolant to a plurality of sources. For example, a plurality of liquid coolant conduits 6 may be directly connected to pump 3, or there may be multiple
35 pumps 3 each connected to a separate liquid coolant conduit 6. The base 19 may be

sloped or arranged in another way to direct or urge used liquid coolant under gravity back to the liquid coolant reservoir 4 for recycling or reuse. Alternatively, additional pumps and conduits may be provided to return the liquid coolant to the liquid coolant reservoir 4.

5 **[060]** A method of manufacturing and/or operating any of the devices disclosed herein is also provided. The method may comprise steps of providing each of features disclosed and/or configuring the respective feature for its stated function.

10 **[061]** All of the features disclosed herein may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive. In particular, the preferred features of each aspect of the disclosure are generally applicable to all aspects of the disclosure and the features of all of the aspects may be used in any combination. Likewise, features described in non-essential combinations may be used separately (not in combination).

CLAIMS

1. An electronic device cooling module comprising:
a container enclosing at least one first electronic device;
5 a liquid coolant reservoir;
a pump located within the liquid coolant reservoir arranged to pump liquid coolant from said liquid coolant reservoir to the at least one first electronic device via a liquid coolant conduit to provide cooling of the device;
wherein the liquid coolant reservoir includes a heating element communicably
10 coupled to a controller, said controller being communicably coupled to a temperature sensor disposed within the liquid coolant reservoir.
2. An electronic device cooling module as claimed in claim 1, wherein the container includes a coolant manifold configured to receive liquid coolant from the liquid coolant
15 reservoir via the pump, the coolant manifold arranged to distribute liquid coolant to a plurality of first electronic devices disposed within the container, each electronic device connected to the coolant manifold by a respective liquid coolant conduit.
3. An electronic device cooling module as claimed in claim 1 or 2, wherein the pump is
20 communicably coupled to the controller.
4. An electronic device cooling module as claimed in any preceding claim, wherein the or each first electronic device is thermally coupled to a respective cooling block assembly, the cooling block assembly being in liquid communication with the or each liquid coolant
25 conduit.
5. An electronic device cooling module as claimed in claim 4, wherein the or each cooling block assembly is configured to allow overflow of liquid coolant from within the cooling block assembly into the interior of the container.
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6. An electronic device cooling module as claimed in claim 5, wherein overflow of liquid coolant from the or each cooling block assembly is directed to at least one proximal second electronic device.

7. An electronic device cooling module as claimed in claim 6, wherein the overflow of liquid coolant from the or each cooling block assembly is directed to the at least one proximal second electronic device via a multi-orifice distribution tray.
- 5 8. An electronic device cooling module as claimed in claim 7, wherein the multi-orifice distribution tray is in direct liquid contact with a respective cooling block assembly.
9. An electronic device cooling module as claimed in any preceding claim, wherein the at least one first electronic device is a central processing unit (CPU) or a graphics processing unit (GPU).
- 10 10. An electronic device cooling module as claimed in any of claims 6 to 8, wherein the at least one proximal second electronic device is a dual in-line memory module (DIMM).
- 15 11. An electronic device cooling module as claimed in claim 5, wherein the cooling block assembly is a heatsink or a coolant cold plate device.
12. An electronic device cooling module as claimed in any preceding claim, wherein the container includes a base arranged to urge liquid coolant within the container to flow towards the liquid coolant reservoir.
- 20 13. An electronic device cooling module as claimed in claim 12, wherein the liquid coolant reservoir is a sump formed in the base of the container.
- 25 14. An electronic device cooling module as claimed in any preceding claim, wherein the controller is configured to receive an indication of a temperature of liquid coolant within the liquid coolant reservoir from the temperature sensor and to control the heating element based on the received indication of the temperature.
- 30 15. An electronic device cooling module as claimed in claim 14, wherein the controller is configured to activate the heating element if the received indication of the temperature is below a predetermined activation temperature, and deactivate the heating element when the liquid coolant is above a predetermined deactivation temperature.

16. An electronic device cooling module as claimed in claim 14 or claim 15, when dependent on claim 3, wherein the controller is further configured to activate the pump to direct liquid coolant from the liquid coolant reservoir to the at least one electronic device if the received indication of the temperature is at least at a predetermined pumping temperature.

17. A method of cooling an electronic device enclosed within an electronic device cooling module, the electronic device cooling module including a container enclosing at least one first electronic device and a liquid coolant reservoir, wherein the method comprises:

10 monitoring a temperature of liquid coolant within the liquid coolant reservoir via a temperature sensor disposed within the liquid coolant reservoir;

activating a heating element within the liquid coolant reservoir if the temperature of the liquid coolant is below a predetermined activation temperature, and deactivating the heating element when the liquid coolant is at or above a predetermined deactivation

15 temperature;

activating a pump located within the liquid coolant reservoir to direct liquid coolant from the liquid coolant reservoir to the at least one electronic device if the temperature of the liquid coolant is at least at a predetermined pumping temperature;

providing cooling of the at least one electronic device with liquid coolant received from

20 the liquid coolant reservoir via a liquid coolant conduit.

18. A method of cooling an electronic device as claimed in claim 17, wherein temperature monitoring, heating element activation/deactivation, and pump activation/deactivation is controlled via a controller device disposed within the electronic device cooling module.

19. A method of cooling an electronic device as claimed in claim 17 or 18, wherein liquid coolant received by the at least one first electronic device is, subsequent to cooling said at least one first electronic device, directed to at least one proximal second electronic device.

20. A method of cooling an electronic device as claimed in any of claims 17 to 19, wherein the liquid coolant received from the liquid coolant reservoir via the liquid coolant conduit is recycled by return to the liquid coolant reservoir under gravity.