

Description

Background of the Invention

This invention relates to forced air cooling of circuit packs which are arranged in a stacked configuration.

The density of heat generating components in electronic circuit packs continues to rise, bringing with it increased concern about proper cooling of the circuits. Forced fluid cooling is expected to be a necessity in the near future, and several proposals have already been made to facilitate such cooling. For example, jet impingement of air onto the heat generating component can be provided through separate plenums (see, e.g., U.S. Pat. No. 4,851,965), or through the circuit board assembly itself. It has also been suggested that air can be blown onto the components through holes in the enclosures or shields surrounding the circuit components (see, e.g., U.S. Pat. No. 4,393,437 and U.S. Pat. No. 4,408,255). It has been suggested further that holes in the circuit boards themselves could allow air to impinge on components in circuit packs which are stacked (see U.S. Pat. No. 4,399,484).

In stacked configurations which are open and where the air is flowing essentially parallel to the circuit packs, there is a problem of stagnant air pockets forming in areas between components. This problem can be solved by introducing turbulators on the wall facing the circuit pack components.

It is desirable to provide an alternative solution to this problem which has the potential for lower cost.

Summary of the Invention

This and other objects are achieved in accordance with the invention which is a fluid-cooled circuit pack comprising a first circuit board having a front surface with at least one heat generating component mounted thereon. Another surface is disposed opposite to the front surface and is spaced in relationship thereto so as to form a channel for the flow of cooling fluid over said component in a direction essentially parallel to said surfaces. An array of perforations is provided at least in the said another surface so that the flow of cooling fluid in the channel causes fluid above the said another surface to be drawn into the channel.

Brief Description of the Drawing

These and other features of the invention are delineated in detail in the following description. In the drawing:

FIG. 1 is a side view of a circuit pack assembly including a fluid flow pattern in accordance with a prior art configuration;

FIG. 2 is a side view of a circuit pack assembly including a fluid flow pattern in accordance with an embodiment of the invention; and

FIG. 3 is a top view of a portion of the assembly in FIG. 2 in accordance with the same embodiment.

It will be appreciated that, for purposes of illustration, these figures are not necessarily drawn to scale.

Detailed Description

FIG. 1 illustrates a typical circuit packet assembly which includes two circuit boards, 10 and 11, in a stacked configuration. Each circuit board includes at least one heat generating component, e.g., 12 and 13, mounted on the front surface of the circuit board. Two channels for the flow of fluid, indicated by the arrows, are shown. One is provided between the back surface of circuit board 11 and the front surface of circuit board 10. The other channel is provided between the front surface of circuit board 11 and another surface 14, which could be a cover or another circuit board in the stack. It will be appreciated that several such channels are formed in a typical shelf of circuit packs.

The fluid, which can be air or liquid, is forced into the channel by some means, such as a fan 15, in a direction which is essentially parallel to the surfaces of the circuit boards. As the air impinges on the components, the flow is as schematically illustrated. It will be noted that areas of stagnant air tend to form between the components in both channels, thereby inhibiting effective cooling.

FIGS. 2 and 3 illustrate, in side and top views, respectively, a circuit pack assembly with improved cooling in accordance with the invention. The assembly, again, includes circuit boards, 20 and 21, with components, e.g. 22 and 23, mounted on their front surfaces. Two channels are also shown, one formed between boards 20 and 21 and one formed between board 21 and surface 24. Air is forced into the channels by fan 25 in a direction essentially parallel to the boards as before. Here, however, an array of fairly large perforations, e.g. 26-29, are formed through board 21 adjacent to each component. As illustrated in FIG. 3, these perforations preferably extend the full length of each component, which is typically 1-2.5 cm. Also, the perforations are fairly wide, i.e., at least 0.60 cm, in order to provide the improved cooling capabilities.

It will be appreciated that air is forced into the channels, as before, essentially parallel to boards 20 and 21 and surface 24. Here, however, the air in the channel just below board 21 will be moving at a faster rate than the stagnant areas adjacent to the components in the channel above board 21. According to Bernoulli's principle, this will result in areas of lesser pressure below the holes 26-29, thereby causing air

from the channel above board 21 to be sucked into the channel below. The areas of stagnant air in the channel bounded by board 21 and cover 24 will, therefore, be dissipated. In addition, the areas of stagnant air in the channel bounded by 20 and 21 will also tend to break up as a result of the increased air turbulence caused by the air being sucked into the channel from above. Further, the components (e.g., 22) on board 20 can receive direct impingement of the cooling fluid through the perforations. Enhanced cooling of the components in both channels is, therefore, realized.

For optimum results, the perforations 28-29 should be located adjacent to each heat generating component in the path of the air flow as shown in FIG. 3. Fluid flow should, preferably, be at least 0.75 m/s to ensure that adequate amounts of fluid will be drawn through the perforations. The area of each perforation should be at least 0.6 cm² for the same reason.

While the invention has been illustrated with the use of surface mount components 22 and 23, boards which include through-hole mounted components can also benefit by placing the perforations adjacent to the through-holes. Known cooling fluids, other than air, can also be employed.

Claims

1. A fluid cooled circuit pack assembly comprising:
a first circuit board (20) having a front surface with at least one heat generating component mounted thereon; and
another surface (21) disposed opposite to the front surface and in spaced relationship thereto

CHARACTERIZED IN THAT

the said another surface forms a channel for the flow of cooling fluid over said component in a direction essentially parallel to said surfaces, and

an array of perforations (28-29) is defined in the said another surface so that flow of cooling fluid in the channel causes fluid above the said another surface to be drawn into the channel.

2. The circuit pack assembly according to claim 1 wherein the said another surface comprises a second circuit board which also includes at least one heat generating component (23) mounted thereon.
3. The circuit pack assembly according to claim 2 wherein the perforations are at least 0.60 cm wide and extend the length of the heat generating component.

4. The circuit pack assembly according to claim 1 wherein the perforations have an area of at least 0.6 cm².
5. The circuit pack assembly according to claim 1 further comprising means (25) for forcing fluid into said channel in a direction essentially parallel to the circuit board.
6. The circuit pack assembly according to claim 5 wherein the means produces a fluid flow with a velocity of at least 0.75 m/s.
7. The circuit pack assembly according to claim 2 wherein the perforations are placed in the second circuit board adjacent to each side of the component which is perpendicular to the flow of cooling fluid.
8. The circuit pack assembly according to claim 7 wherein the second circuit board includes a plurality of components and perforations are formed adjacent to each side of each component which is perpendicular to the direction of fluid flow.

Patentansprüche

1. Fluidgekühlte Schaltungspack-Anordnung mit einer ersten Schaltungsplatte (20), die eine Vorderfläche mit mindestens einem daran angebrachten wärmeerzeugenden Bauteil aufweist, und
mit einer weiteren Oberfläche (21), die gegenüber der Vorderfläche im Abstand von dieser angeordnet ist, dadurch gekennzeichnet, daß die weitere Oberfläche einen Kanal für die Strömung von Kühlfluid über das Bauteil in Richtung im wesentlichen parallel zu den Oberflächen bildet und daß eine Reihe von Perforationen (28-29) in dieser weiteren Oberfläche bestimmt ist, so daß der Kühlfluidstrom in dem Kanal das Fluid oberhalb der weiteren Oberfläche dazu bringt, in den Kanal gesogen zu werden.
2. Schaltungspack-Anordnung nach Anspruch 1, dadurch gekennzeichnet, daß die weitere Oberfläche eine zweite Schaltungsplatte umfaßt, die ebenfalls mindestens ein daran angebrachtes wärmeerzeugendes Bauteil (23) aufweist.
3. Schaltungspack-Anordnung nach Anspruch 2, dadurch gekennzeichnet, daß die Perforationen mindestens 0,60 cm breit sind und sich in der Länge des wärmeerzeugenden Bauteils erstrecken.
4. Schaltungspack-Anordnung nach Anspruch 1,



from the channel above board 21 to be sucked into the channel below. The areas of stagnant air in the channel bounded by board 21 and cover 24 will, therefore, be dissipated. In addition, the areas of stagnant air in the channel bounded by 20 and 21 will also tend to break up as a result of the increased air turbulence caused by the air being sucked into the channel from above. Further, the components (e.g., 22) on board 20 can receive direct impingement of the cooling fluid through the perforations. Enhanced cooling of the components in both channels is, therefore, realized.

For optimum results, the perforations 28-29 should be located adjacent to each heat generating component in the path of the air flow as shown in FIG. 3. Fluid flow should, preferably, be at least 0.75 m/s to ensure that adequate amounts of fluid will be drawn through the perforations. The area of each perforation should be at least 0.6 cm² for the same reason.

While the invention has been illustrated with the use of surface mount components 22 and 23, boards which include through-hole mounted components can also benefit by placing the perforations adjacent to the through-holes. Known cooling fluids, other than air, can also be employed.

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1. A fluid cooled circuit pack assembly comprising:
a first circuit board (20) having a front surface with at least one heat generating component mounted thereon; and
another surface (21) disposed opposite to the front surface and in spaced relationship thereto
CHARACTERIZED IN THAT
the said another surface forms a channel for the flow of cooling fluid over said component in a direction essentially parallel to said surfaces, and
an array of perforations (26-29) is defined in the said another surface so that flow of cooling fluid in the channel causes fluid above the said another surface to be drawn into the channel.
2. The circuit pack assembly according to claim 1 wherein the said another surface comprises a second circuit board which also includes at least one heat generating component (23) mounted thereon.
3. The circuit pack assembly according to claim 2 wherein the perforations are at least 0.60 cm wide and extend the length of the heat generating component.

4. The circuit pack assembly according to claim 1 wherein the perforations have an area of at least 0.6 cm².
5. The circuit pack assembly according to claim 1 further comprising means (25) for forcing fluid into said channel in a direction essentially parallel to the circuit board.
6. The circuit pack assembly according to claim 5 wherein the means produces a fluid flow with a velocity of at least 0.75 m/s.
7. The circuit pack assembly according to claim 2 wherein the perforations are placed in the second circuit board adjacent to each side of the component which is perpendicular to the flow of cooling fluid.
8. The circuit pack assembly according to claim 7 wherein the second circuit board includes a plurality of components and perforations are formed adjacent to each side of each component which is perpendicular to the direction of fluid flow.

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1. Fluidgekühlte Schaltungspack-Anordnung mit einer ersten Schaltungsplatte (20), die eine Vorderfläche mit mindestens einem daran angebrachten wärmeerzeugenden Bauteil aufweist, und
mit einer weiteren Oberfläche (21), die gegenüber der Vorderfläche im Abstand von dieser angeordnet ist, dadurch gekennzeichnet, daß die weitere Oberfläche einen Kanal für die Strömung von Kühlfluid über das Bauteil in Richtung im wesentlichen parallel zu den Oberflächen bildet und daß eine Reihe von Perforationen (26-29) in dieser weiteren Oberfläche bestimmt ist, so daß der Kühlfluidstrom in dem Kanal das Fluid oberhalb der weiteren Oberfläche dazu bringt, in den Kanal gesogen zu werden.
2. Schaltungspack-Anordnung nach Anspruch 1, dadurch gekennzeichnet, daß die weitere Oberfläche eine zweite Schaltungsplatte umfaßt, die ebenfalls mindestens ein daran angebrachtes wärmeerzeugendes Bauteil (23) aufweist.
3. Schaltungspack-Anordnung nach Anspruch 2, dadurch gekennzeichnet, daß die Perforationen mindestens 0,60 cm breit sind und sich in der Länge des wärmeerzeugenden Bauteils erstrecken.
4. Schaltungspack-Anordnung nach Anspruch 1,



dadurch gekennzeichnet, daß die Perforationen eine Fläche von mindestens 0,6 cm² aufweisen.

5. Schaltungs-pack-Anordnung nach Anspruch 1, gekennzeichnet durch eine Einrichtung (25) zur Förderung von Fluid in dem Kanal in eine Richtung im wesentlichen parallel zu der Schaltungsplatte.
6. Schaltungs-pack-Anordnung nach Anspruch 5, dadurch gekennzeichnet, daß die Einrichtung einen Fluidstrom mit einer Geschwindigkeit von mindestens 0,75 m/s erzeugt.
7. Schaltungs-pack-Anordnung nach Anspruch 2, dadurch gekennzeichnet, daß die Perforationen in der zweiten Schaltungsplatte benachbart jeder Seite des Bauteils angeordnet sind, die senkrecht zum Strom des Kühlfluids ist.
8. Schaltungs-pack-Anordnung nach Anspruch 7, dadurch gekennzeichnet, daß die zweite Schaltungsplatte eine Mehrzahl von Bauteilen umfaßt und daß Perforationen benachbart jeder Seite jedes Bauteils gebildet sind, welche senkrecht zur Richtung des Fluidstroms ist.

Revendications

1. Ensemble de plaques à circuits imprimés à refroidissement par fluide comprenant:
 - une première carte à circuits imprimés (20) ayant une surface frontale avec au moins un composant thermogène monté sur celle-ci; et
 - une autre surface (21) disposée en regard de la surface frontale et espacée par rapport à celle-ci

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ladite autre surface forme un canal pour l'écoulement de fluide de refroidissement par-dessus ledit composant dans une direction essentiellement parallèle auxdites surfaces, et une série de perforations (26-29) est définie dans ladite autre surface de sorte que l'écoulement de fluide de refroidissement dans le canal provoque l'aspiration dans le canal du fluide passant par-dessus ladite autre surface.

2. Ensemble de plaques à circuits imprimés selon la revendication 1, dans lequel ladite autre surface comprend une seconde carte à circuits imprimés qui comporte également au moins un composant thermogène (23) monté sur celle-ci.
3. Ensemble de plaques à circuits imprimés selon la revendication 2, dans lequel les perforations ont au moins une largeur de 0,60 cm et s'étendent

sur la longueur du composant thermogène.

4. Ensemble de plaques à circuits imprimés selon la revendication 1, dans lequel les perforations ont une surface d'au moins 0,6 cm².
5. Ensemble de plaques à circuits imprimés selon la revendication 1, comprenant en outre un moyen (25) pour forcer le fluide dans ledit canal dans une direction essentiellement parallèle à la carte à circuits imprimés.
6. Ensemble de plaques à circuits imprimés selon la revendication 5, dans lequel le moyen produit un écoulement de fluide ayant une vitesse d'au moins 0,75 m/s.
7. Ensemble de plaques à circuits imprimés selon la revendication 2, dans lequel les perforations sont placées dans la seconde carte à circuits imprimés le long de chaque côté du composant qui est perpendiculaire à l'écoulement de fluide de refroidissement.
8. Ensemble de plaques à circuits imprimés selon la revendication 7, dans lequel la seconde carte à circuits imprimés comporte une pluralité de composants et des perforations sont formées le long de chaque côté de chaque composant qui est perpendiculaire à la direction de l'écoulement de fluide.