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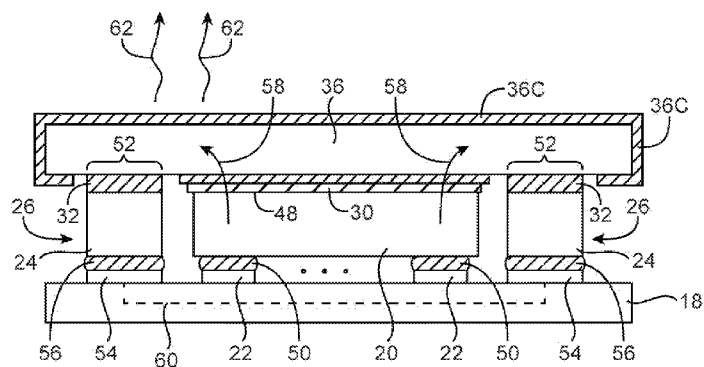
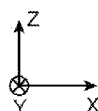


FIG. 3



(57) Abstract: An electronic device may be provided with electronic components such as radio-frequency transceiver integrated circuits and other integrated circuits that are sensitive to electromagnetic interference. Metal structures are configured to serve both as heat sinking structures for the electrical components and electromagnetic interference shielding. Components are mounted to the substrate using solder. Metal fence structures are also soldered to the substrate. Each metal fence has an opening that covers a respective one of the components. A thermally conductive elastomeric gap filler pad is mounted in the opening. A metal heat spreading structure is electrically shorted to the fence using a conductive gasket that surrounds the gap filler pad so that the structure serves as an electromagnetic interference shield. Heat from the component travels through the gap filler pad to the metal heat spreading structure so that the heat spreading structure may laterally spread and dissipate the heat.

Heat Sinking and Electromagnetic Shielding Structures

This application claims priority to United States patent application No. 13/623,436 filed September 20, 2012, is hereby incorporated by reference herein in its entirety.

5

Background

This relates generally to electronic devices and, more particularly, to radio-frequency shielding and thermal management structures for components in electronic
10 devices.

Electronic devices often contain components such as radio-frequency transmitters and other circuits that use electromagnetic interference (EMI) shielding structures. Electromagnetic interference shielding
15 structures may help prevent radio-frequency signals that are generated by one component from disrupting the operation of another component that is sensitive to radio-frequency interference. Electromagnetic shielding structures may be formed from metal shielding cans
20 soldered to printed circuit boards. A typical shielding

has an inner metal fence and an outer metal lid structure.

The operation of integrated circuits such as radio-frequency transmitters and other circuitry tends to generate heat. To properly dissipate heat that is
5 generated during operation, heat sink structures may be thermally coupled to the exterior of an electromagnetic shielding can. To ensure satisfactory heat transfer from a shielded integrated circuit to a heat sink, a thermally
10 conductive elastomeric pad may be interposed between the integrated circuit and the shielding can to fill air gaps between the integrated circuit and the shielding can and another thermally conductive elastomeric pad may be interposed between the shielding can and the heat sink. The use of multiple thermally conductive paths and
15 separate heat sink and electromagnetic interference shielding structures tends to make designs of this type complex and costly and may reduce the efficacy of the overall structure in removing heat from a component during operation.

20 It would therefore be desirable to be able to provide improved ways in which to provide components in electronic devices with heat sinking and electromagnetic interference shielding structures.

25 Summary

An electronic device may be provided with electronic components such as radio-frequency transceiver integrated circuits and other integrated circuits that are sensitive to electromagnetic interference. Metal heat
30 spreading structures can be configured to serve both as heat sinking structures for the electrical components and electromagnetic interference shielding.

The electronic components are mounted to a

dielectric substrate using solder. The dielectric substrate is formed from a rigid or flexible printed circuit or other dielectric material. Metal fence structures are soldered to the substrate over the
5 components. Each metal fence has an opening that overlaps a respective one of the components. A thermally conductive structure such as an elastomeric gap filler pad is mounted in each opening.

The metal heat spreading structures are
10 electrically shorted to each fence structure using a conductive gasket that surrounds the gap filler pad in that fence. This allows the metal heat spreading structure to serve as part of an electromagnetic interference shield.

15 Heat from the components travels through the gap filler pads on the components to the metal heat spreading structure. The heat spreading structure may laterally spread and dissipate the heat.

If desired, a heat spreading structure may be
20 mounted directly over a component. In this type of configuration, sidewall portions of the heat spreading structure are shorted to traces on the substrate. A recess in the heat spreading structure is configured to receive the component. A gap filler or other thermally
25 conductive structure is interposed between the component and the upper surface of the recess.

Further features, their nature and various advantages will be more apparent from the accompanying drawings and the following detailed description of the
30 preferred embodiments.

Brief Description of the Drawings

FIG. 1 is a perspective view of an illustrative

electronic device of the type that may be provided with electromagnetic interference shielding and thermal management structures in accordance with an embodiment.

FIG. 2 is an exploded perspective view of an illustrative electronic device with electromagnetic interference shielding and thermal management structures in accordance with an embodiment.

FIG. 3 is a cross-sectional side view of electromagnetic interference shielding and thermal management structures in accordance with an embodiment.

FIG. 4 is a cross-sectional side view of an electronic device having a housing in which electromagnetic interference shielding and thermal management structures have been installed in accordance with an embodiment.

FIG. 5 is a cross-sectional side view of an electronic device having a housing that is used in forming electromagnetic interference shielding and thermal management structures in accordance with an embodiment.

FIG. 6 is an exploded rear perspective view of an illustrative electronic device with electromagnetic interference shielding and thermal management structures in accordance with an embodiment.

FIG. 7 is a cross-sectional side view of electromagnetic interference shielding and thermal management structures that have been coupled to a printed circuit substrate and that include a recess for accommodating a component in accordance with an embodiment.

FIG. 8 is a cross-sectional side view of electromagnetic interference shielding and thermal management structures that have been coupled to a metal fence structure on a printed circuit substrate in

accordance with an embodiment.

Detailed Description

An electronic device may be provided with
5 electronic components such as integrated circuits. These
components may be provided with electromagnetic
interference and heat sinking structures (sometimes
referred to as heat spreading structures, heat spreaders,
heat spreader structures, or thermal management
10 structures). An illustrative electronic device is shown
in FIG. 1. Electronic device 10 of FIG. 1 has openings 14
in housing 12. Openings 14 form connector ports for
connectors such as Ethernet plugs, Universal Serial Bus
connectors, power connectors, audio jacks, and other
15 connectors. Housing 12, which may sometimes be referred
to as an enclosure or case, may be formed of plastic,
glass, ceramics, fiber composites, metal (e.g., stainless
steel, aluminum, etc.), other suitable materials, or a
combination of any two or more of these materials.
20 Housing 12 may be formed using a unibody configuration in
which some or all of housing 12 is machined or molded as a
single structure or can be formed using multiple
structures (e.g., an internal frame structure, one or more
structures that form exterior housing surfaces, etc.).
25 Electronic device 10 of FIG. 1 is a set-top box
that provides video signals to a television or other
display. If desired, electronic device 10 may be
implemented using other types of equipment such as
cellular telephones, media players, other handheld
30 portable devices, somewhat smaller portable devices such
as wrist-watch devices, pendant devices, or other wearable
or miniature devices, gaming equipment, tablet computers,
notebook computers, desktop computers, televisions,

computer monitors, computers integrated into computer displays, wireless access points, or other electronic equipment. The use of a set-top box form factor in implementing device 10 is merely illustrative.

5 An exploded perspective view of device 10 is shown in FIG. 2. As shown in FIG. 2, device 10 has housing base structure 16. Housing structure 16 has sidewall portions 46 that surround recessed rear portion 44. Housings with other shapes and sizes may be used for
10 device 10 if desired.

 Components 20 are mounted on dielectric substrate 18. Components 20 may include integrated circuits, discrete components such as resistors, capacitors, and inductors, connectors, and other
15 circuitry. Examples of integrated circuits that may be used in forming components 20 include memory circuits, clock circuits, display driver circuits, radio-frequency integrated circuits such a radio-frequency transceiver circuitry associated with cellular telephone
20 communications, radio-frequency transceiver circuitry associated with wireless local area network (WLAN) communications, satellite navigation system integrated circuits such as a Global Positioning System receiver, wireless radio-frequency transceiver circuitry for
25 Bluetooth® communications, processors, power amplifiers, timing circuits, wireless circuits, and other circuitry. Substrate 18 may be a printed circuit board, a flexible printed circuit such as a printed circuit formed from a flexible sheet of polyimide or a layer of other polymer
30 material, a rigid printed circuit board formed from fiberglass-filled epoxy or other printed circuit board substrate material, a dielectric such as plastic, glass, or ceramic, or other insulating material. Configurations

in which dielectric substrate 18 is a printed circuit are sometimes described herein as an example.

Components 20 are soldered on printed circuit substrate 18 using solder. Fences 26 have leg portions 24
5 that are soldered to printed circuit substrate 22 using solder on solder pads 22. Fences 26 are formed from metal. Other types of materials may be used to form fences if desired. Fences 26 have openings 28. Openings 28 overlap components 20 and have shapes and sizes that
10 are configured to expose upper surfaces 48 of components 20.

Thermally conductive elastomeric pads 30, which may sometimes be referred to as gap-filling pads or gap pads, have shapes such as rectangular shapes that are
15 configured to be received within openings 28. Elastomeric pads 30 are formed from elastomeric polymer material filled with thermally conductive material such as metal particles. During operation of device 10, thermally conductive pads 30 are compressed between upper surfaces
20 48 of components 20 and the lower surface of structures 36. Structures 36 are formed from metal and are therefore thermally and electrically conductive. With one illustrative configuration, structures 36 are formed from aluminum. Examples of other materials that may be used in
25 forming structures 36 include stainless steel and carbon-fiber composites or other fiber-based composites.

Conductive structures such as conductive gaskets 32 are used to couple fences 26 to metal structure 36. Conductive gaskets 32 have shapes that are configured to
30 match the outlines of fences 26. Conductive gaskets 32 may, as an example, have rectangular ring shapes with outlines that match the rectangular outlines of fences 26 and openings 34 that match the shape of gap pads 30 and

openings 28. Examples of materials that may be used in forming conductive gaskets 26 include compressible materials such as conductive foam, conductive adhesive, and conductive fabric (e.g., fabric formed from thin metal wires and/or plastic wires coated with metal).

Because metal structures 36 are sufficiently thermally conductive to spread and help dissipate heat, metal structures 36 may sometimes be referred to as metal heat spreader structures, metal thermal management structures, or metal heat sink structures. Metal structures 36 can be configured to mate with structures 16 so that structures 36 and 16 form some or all of a metal housing for device 10 (i.e., so that structures 36 and 16 form housing 12 of FIG. 1). If desired, optional housing structure 38 can be configured to mate with structures 16. Optional housing structures 38 may be formed from plastic, metal, or other materials and may have a shape that covers metal structure 36. In configurations in which housing structures 38 and structure 16 form housing 12 in this way, housing structures 38 can be provided with a recess or other shape that receives heat spreader 36.

When assembled to form device 10, electromagnetic shielding functions are provided by the metal of fences 26, conductive gasket structures 32, and the metal of structures 36. Ground plane metal (e.g., ground traces) in substrate 18 and/or metal in housing portion 16 may also be used in forming electromagnetic shielding functions. Thermal conduction is provided by gap pads 30 and metal structure 36. Metal structure 36 therefor serves both as an electromagnetic shielding structure that prevents interference from disruption device operation and as a heat sink that dissipates heat from underlying components 20.

A cross-sectional view of device 10 of FIG. 2 taken along line 40 and viewed in direction 42 is shown in FIG. 3. As shown in FIG. 3, vertically extending leg portions 24 of fence 26 are soldered to metal solder pads 54 on substrate 18 using solder 56. Electrical component 20 (e.g., an integrated circuit) is soldered to metal solder pads 22 on substrate 18 using solder 50.

Metal structure 36 of FIG. 3 is formed from aluminum and has a thin insulating coating. Coating 36C in the FIG. 3 example is formed from aluminum oxide. Other insulating coatings may be formed on metal structure 36 and metal structure 36 may be formed from materials other than aluminum, if desired.

To ensure that metal structure 36 is electrically connected to gasket 32 and fence 26 (and, if desired, to internal metal traces such as metal ground traces 60 in substrate 18), insulating coating 36C is removed (e.g., by laser etching or other suitable removal techniques) from regions 52 on the underside of metal structure 36. Because regions 52 are free of insulating material (i.e., because regions 52 are associated with exposed metal), conductive gasket 32 electrically shorts fence 26 to metal structures 36. This allows metal structures 36 (in combination with fence 26 and, if desired, traces 60) to form an electromagnetic interference shield for component 20.

Gap filler pad 30 is compressed between upper surface 48 of component 20 and the opposing lower surface of metal structure 36. This provides a thermal path between component 20 and structure 36. Gap pad 30 has a relatively high thermal conductivity. The high thermal conductivity of gap pad 30 (e.g., 0.3 W/mK or more, 1 W/mK or more, or 2.5 W/mK or more) allows heat to flow from

component 20 to structure 36 in vertical dimension Z and to spread laterally outward in the X-Y plane of FIG. 3, as illustrated by lines 58. Lines 62 show how the heat that has been spread throughout structure 36 in this way
5 dissipates outwards into the surrounding environment. Structure 36 therefore serves not only as an electromagnetic interference shield for component 20, but also serves as a heat sinking structure for component 20. The configuration used for the metal structures of FIG. 3
10 therefore integrates thermal management features and electromagnetic shielding.

If desired, housing 12 may be formed from structures that are separate from metal structure 36. This type of configuration is shown in FIG. 4. As shown
15 in FIG. 4, multiple components 20 may be mounted on substrate 18. Housing 12 of FIG. 4 includes upper structure 38 and lower structure 16. Upper structure 38 and lower structure 16 are formed from a material such as metal, plastic, or fiber-based composite material (as
20 examples). Metal structure 36 overlaps one or more components 20. Upper housing structure 38 serves as a cover that overlaps and covers the upper surface of metal structure 36. Upper housing structure 38 of FIG. 4 also have sidewalls that cover the edges of device 10 and that
25 mate with the peripheral edges of lower housing structure 16.

In the illustrative configuration of FIG. 5, housing 12 is formed from metal structure 36 and structure 16. Metal structure 36 has sidewall portions 36W that
30 serve as housing sidewalls. Metal structure 36 mates with housing structure 16 along the lower edges of sidewalls 36W. Because no separate housing structure is used to cover the exposed upper surface of metal structure 36 in

the configuration of FIG. 5, heat 62 may be radiated directly into the surrounding environment from metal structure 36 without passing through intermediate housing structures.

5 FIG. 6 is an exploded rear perspective view of device 10 (with lower housing portion 16 removed) in a configuration in which screws 90 are used to attach substrate 18 to device 10. Substrate 18 has screw holes 92 through which the shafts of screws 90 pass. Screws 96
10 are used to attach metal structure 36 to housing structure 38. Screws 96 have threaded holes 94 that are configured to receive the threaded shafts of screws 90. Portions 36C of metal structure 36 are coated with an insulating coating such as aluminum oxide, but portions 52 are free
15 of insulating coating. When substrate 18 is screwed into place on metal structure 52, gasket structures 32 are compressed against bare metal portion 52 of metal structure 36. Housing 38 of FIG. 6 contains components 98 in addition to the components that are covered with metal
20 structure 36.

 If desired, metal structure 36 may be mounted directly to substrate 18. This type of configuration is shown in FIG. 7. As shown in FIG. 7, metal structure 36 has one or more recesses (cavities) such as recess 100
25 that are configured to receive components such as component 20. Thermally conductive gap filler pad 30 is coupled between component 20 and the inner surface of recess 100 to transfer heat from component 20 to metal structure 36 during operation.

30 Portions 36V of metal structure 36 form sidewalls that help enclose and electromagnetically shield component 20. To electrically couple metal structure 36 to metal traces in substrate 18 such as metal trace

(solder pad) 102 and internal traces 60 (e.g., ground traces), conductive structures 104 are coupled between metal structures 36 (i.e., portions 36V) and traces 102. Conductive structures 104 may be formed from conductive
5 adhesive, conductive fabric (e.g., metal wool or plastic fibers covered with metal), conductive foam, conductive elastomeric material, other compressible conductive materials, solder, welds, metal springs, or combinations of these structures. Metal structure 36 is formed from a
10 metal such as aluminum and is covered with an insulating coating such as aluminum oxide. Portion 52 of metal structure 36 is free of aluminum to allow metal structure 36 to be electrically shorted to metal traces such as metal trace 102 through conductive structures 104.

15 FIG. 8 is a cross-sectional side view of device 10 in a configuration of the type shown in FIG. 7 where metal structure 36 contacts protruding portions 108 of fence 26. Component 20 may protrude into a recess in the lower portion of metal structure 36 or may lie flush with
20 the lower surface of metal structure 36. A thermally conductive gap filler pad (see, e.g., pad 30 of FIG. 2) is interposed between component 20 and metal structure 36 to enhance thermal conductivity. Metal protrusions 108
(e.g., metal spring structures) may be located no more
25 than a quarter of a wavelength apart at radio-frequency operating frequencies of interest, to ensure that fence 26 and metal structure 36 provide satisfactorily shielding for electromagnetic interference. If desired, protrusions 108 may be supplemented by or replaced by conductive
30 structures such as conductive adhesive, conductive fabric, conductive foam, conductive elastomeric material, other compressible conductive materials, solder, welds, or combinations of these materials.

In accordance with an embodiment, an electronic device is provided that includes a dielectric substrate, at least one electrical component mounted on the dielectric substrate, and a metal heat spreader structure
5 that is configured to dissipate heat from the electrical component and that is configured to serve as part of an electromagnetic interference shield for the electrical component.

In accordance with another embodiment, the
10 electronic device includes a metal fence surrounding the electrical component where the metal heat spreader structure is shorted to the metal fence.

In accordance with another embodiment, the electronic device includes a conductive gasket that is
15 interposed between the metal heat spreader structure and the metal fence and that electrically shorts the metal structure to the metal frame.

In accordance with another embodiment, the conductive gasket includes a conductive material selected
20 from the group consisting of conductive foam, conductive fabric, and conductive adhesive.

In accordance with another embodiment, the metal heat spreader structure includes aluminum coated with aluminum oxide, where the aluminum has an exposed portion
25 that is free of the aluminum oxide, and the conductive gasket electrically shorts the metal frame to the exposed portion.

In accordance with another embodiment, the electronic device includes a thermally conductive
30 elastomeric gap filler pad interposed between the component and the metal heat spreader structure.

In accordance with another embodiment, the metal heat spreader structure is configured to form an exterior

surface of a housing for the electronic device.

In accordance with another embodiment, the electronic device includes a housing structure that covers the metal heat spreader structure.

5 In accordance with another embodiment, the metal fence has an opening over the electrical component and the thermally conductive elastomeric gap filler pad is received within the opening.

10 In accordance with another embodiment, the electronic device includes solder pads on the dielectric substrate and solder with which the metal fence is soldered to the solder pads.

15 In accordance with another embodiment, the dielectric substrate includes holes; the electronic device further includes screws with which the substrate is attached to the metal heat spreader structure.

In accordance with another embodiment, the metal fence includes protruding portions that contact the metal heat spreader structure.

20 In accordance with another embodiment, the metal heat spreader structure has a recess that is configured to receive at least part of the electrical component.

In accordance with another embodiment, the dielectric substrate includes a printed circuit.

25 In accordance with another embodiment, the component includes a radio-frequency transceiver integrated circuit.

In accordance with an embodiment, apparatus for heat sinking and electromagnetically shielding an
30 integrated circuit is provided that includes a substrate to which the integrated circuit is mounted, a metal heat spreading structure having a recess that covers the integrated circuit, at least one metal trace on the

substrate, and solder that solders the metal heat spreading structure to the metal trace.

In accordance with another embodiment, the apparatus includes a thermally conductive elastomeric gap
5 filler pad interposed between the integrated circuit and the metal heat spreading structure.

In accordance with another embodiment, the metal heat spreading structure includes aluminum coated with aluminum oxide and a portion of the aluminum oxide is
10 removed to form an aluminum-oxide-free region that is soldered to the metal trace with the solder.

In accordance with another embodiment, the substrate includes a printed circuit and the integrated circuit includes a radio-frequency transceiver.

15 In accordance with an embodiment, an electronic device is provided that includes a printed circuit having solder pads, an integrated circuit mounted on the printed circuit, a metal fence structure soldered to the solder pads, the metal fence structure has an opening that
20 overlaps the integrated circuit, a thermally conductive layer of material in the opening that contacts the integrated circuit, and a metal heat sink structure that contacts the thermally conductive layer of material.

In accordance with another embodiment, the
25 integrated circuit includes a radio-frequency transceiver, the metal heat sink structure includes aluminum covered at least partly with an insulating coating, and a portion of the aluminum is free of the insulating coating and is electrically shorted to the metal fence structure.

30 In accordance with another embodiment, the electronic device includes a compressible conductive gasket interposed between the portion of the aluminum that is free of the insulating coating and the metal fence

structure.

The foregoing is merely illustrative and various modifications can be made by those skilled in the art without departing from the scope and spirit of the
5 described embodiments. The foregoing embodiments may be implemented individually or in any combination.

What is Claimed is:

1. An electronic device, comprising:
a dielectric substrate;
at least one electrical component mounted on the dielectric substrate; and
a metal heat spreader structure that is configured to dissipate heat from the electrical component and that is configured to serve as part of an electromagnetic interference shield for the electrical component.
2. The electronic device defined in claim 1 further comprising:
a metal fence surrounding the electrical component, wherein the metal heat spreader structure is shorted to the metal fence.
3. The electronic device defined in claim 2 further comprising a conductive gasket that is interposed between the metal heat spreader structure and the metal fence and that electrically shorts the metal structure to the metal frame.
4. The electronic device defined in claim 3 wherein the conductive gasket comprises a conductive material selected from the group consisting of:
conductive foam, conductive fabric, and conductive adhesive.
5. The electronic device defined in claim 3 wherein the metal heat spreader structure comprises aluminum coated with aluminum oxide, wherein the aluminum has an exposed portion that is free of the aluminum oxide,

and wherein the conductive gasket electrically shorts the metal frame to the exposed portion.

6. The electronic device defined in claim 5 further comprising a thermally conductive elastomeric gap filler pad interposed between the component and the metal heat spreader structure.

7. The electronic device defined in claim 6 wherein the metal heat spreader structure is configured to form an exterior surface of a housing for the electronic device.

8. The electronic device defined in claim 6 further comprising a housing structure that covers the metal heat spreader structure.

9. The electronic device defined in claim 6 wherein the metal fence has an opening over the electrical component and wherein the thermally conductive elastomeric gap filler pad is received within the opening.

10. The electronic device defined in claim 2 further comprising solder pads on the dielectric substrate and solder with which the metal fence is soldered to the solder pads.

11. The electronic device defined in claim 2 wherein the dielectric substrate comprises holes, the electronic device further comprising screws with which the substrate is attached to the metal heat spreader structure.

12. The electronic device defined in claim 2 wherein the metal fence comprises protruding portions that contact the metal heat spreader structure.

13. The electronic device defined in claim 2 wherein the metal heat spreader structure has a recess that is configured to receive at least part of the electrical component.

14. The electronic device defined in claim 2 wherein the dielectric substrate comprises a printed circuit.

15. The electronic device defined in claim 1 wherein the component comprises a radio-frequency transceiver integrated circuit.

16. Apparatus for heat sinking and electromagnetically shielding an integrated circuit, comprising:

- a substrate to which the integrated circuit is mounted;
- a metal heat spreading structure having a recess that covers the integrated circuit;
- at least one metal trace on the substrate;
- and
- solder that solders the metal heat spreading structure to the metal trace.

17. The apparatus defined in claim 16 further comprising:

- a thermally conductive elastomeric gap filler pad interposed between the integrated circuit and

the metal heat spreading structure.

18. The apparatus defined in claim 17 wherein the metal heat spreading structure comprises aluminum coated with aluminum oxide and wherein a portion of the aluminum oxide is removed to form an aluminum-oxide-free region that is soldered to the metal trace with the solder.

19. The apparatus defined in claim 18 wherein the substrate comprises a printed circuit and wherein the integrated circuit comprises a radio-frequency transceiver.

20. An electronic device, comprising:
a printed circuit having solder pads;
an integrated circuit mounted on the printed circuit;
a metal fence structure soldered to the solder pads, wherein the metal fence structure has an opening that overlaps the integrated circuit;
a thermally conductive layer of material in the opening that contacts the integrated circuit; and
a metal heat sink structure that contacts the thermally conductive layer of material.

21. The electronic device defined in claim 20 wherein the integrated circuit comprises a radio-frequency transceiver, wherein the metal heat sink structure comprises aluminum covered at least partly with an insulating coating, and wherein a portion of the aluminum is free of the insulating coating and is electrically shorted to the metal fence structure.

22. The electronic device defined in claim 21 further comprising a compressible conductive gasket interposed between the portion of the aluminum that is free of the insulating coating and the metal fence structure.

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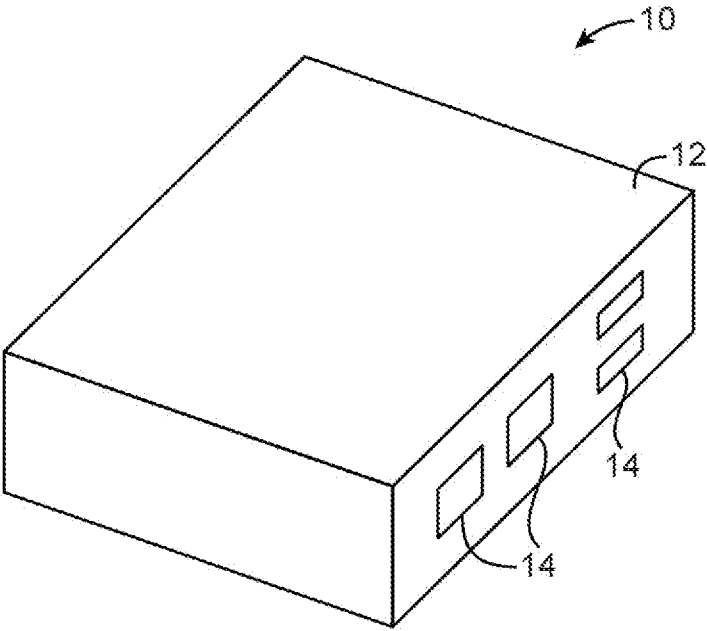


FIG. 1

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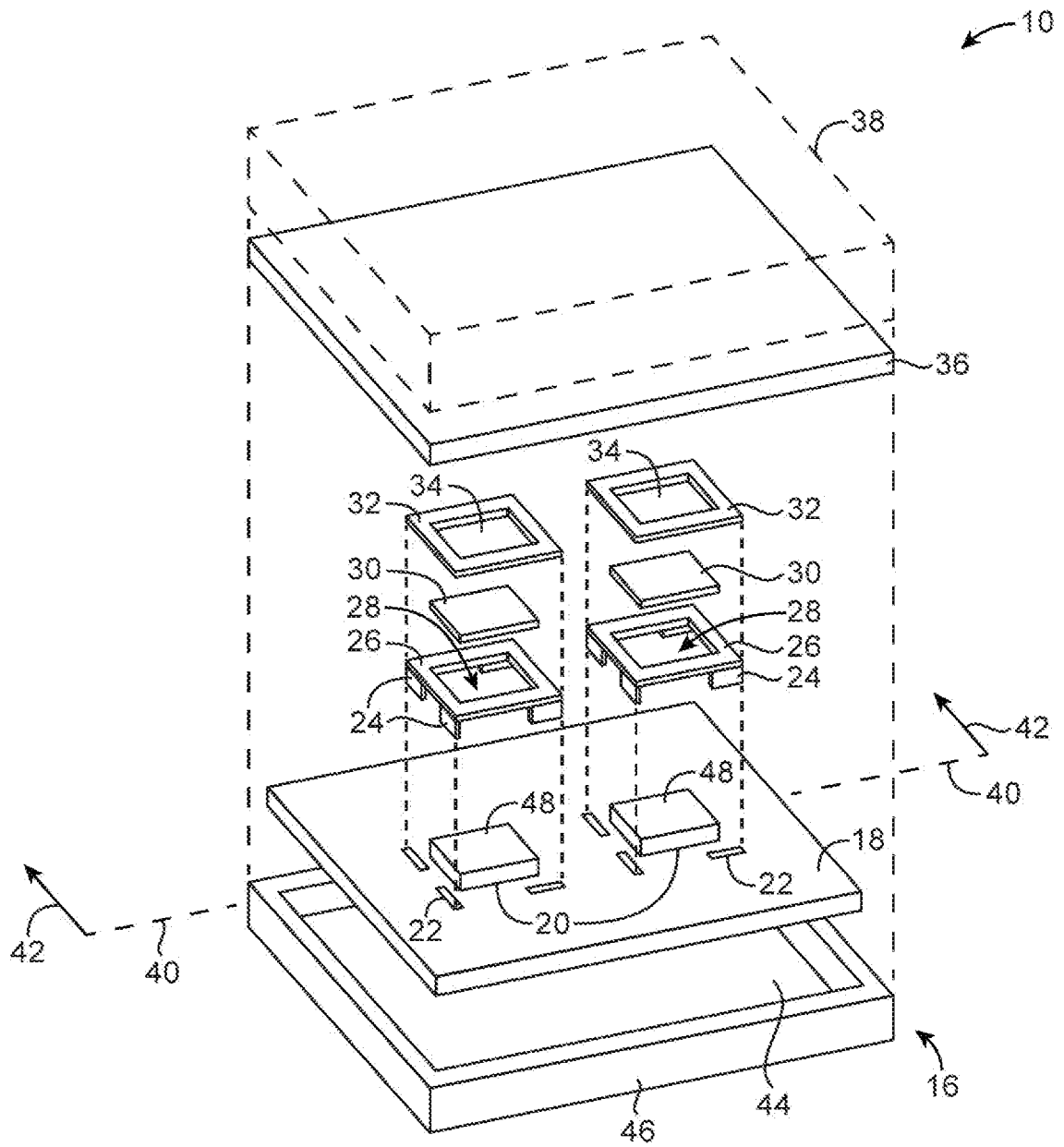
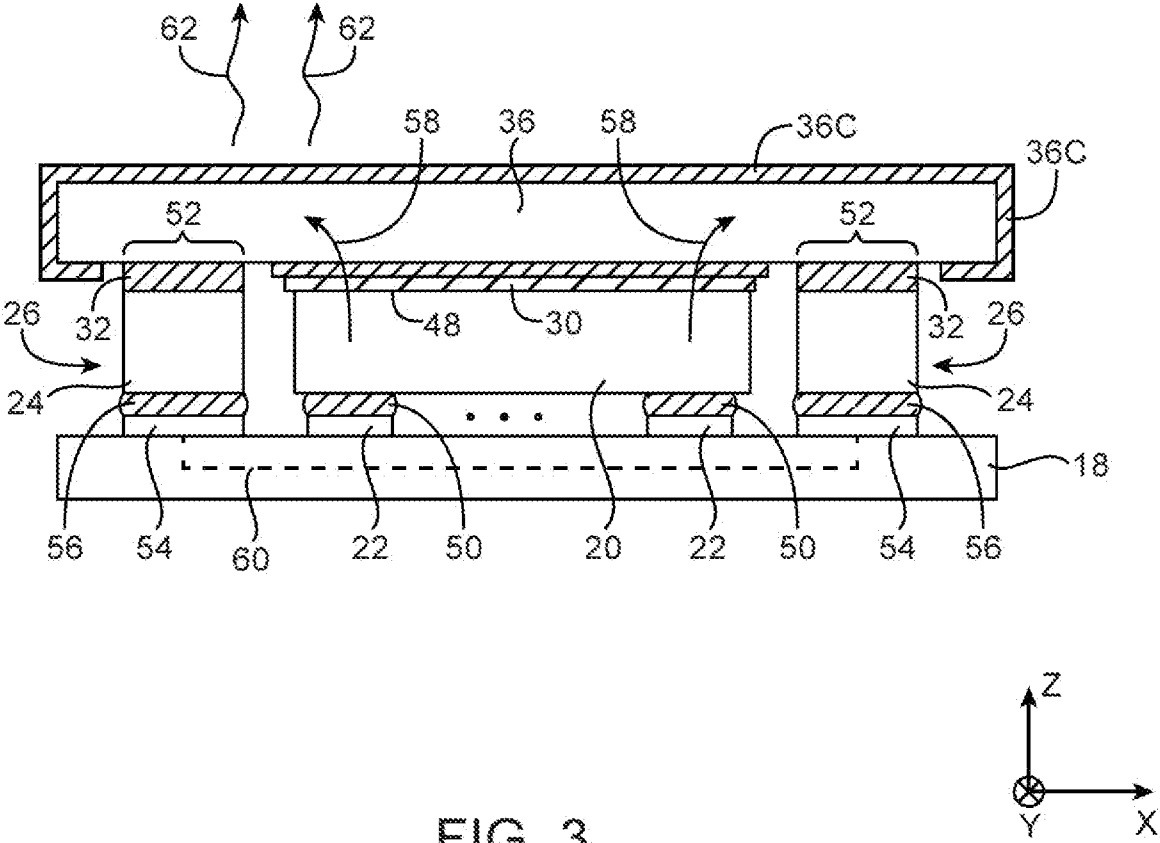


FIG. 2



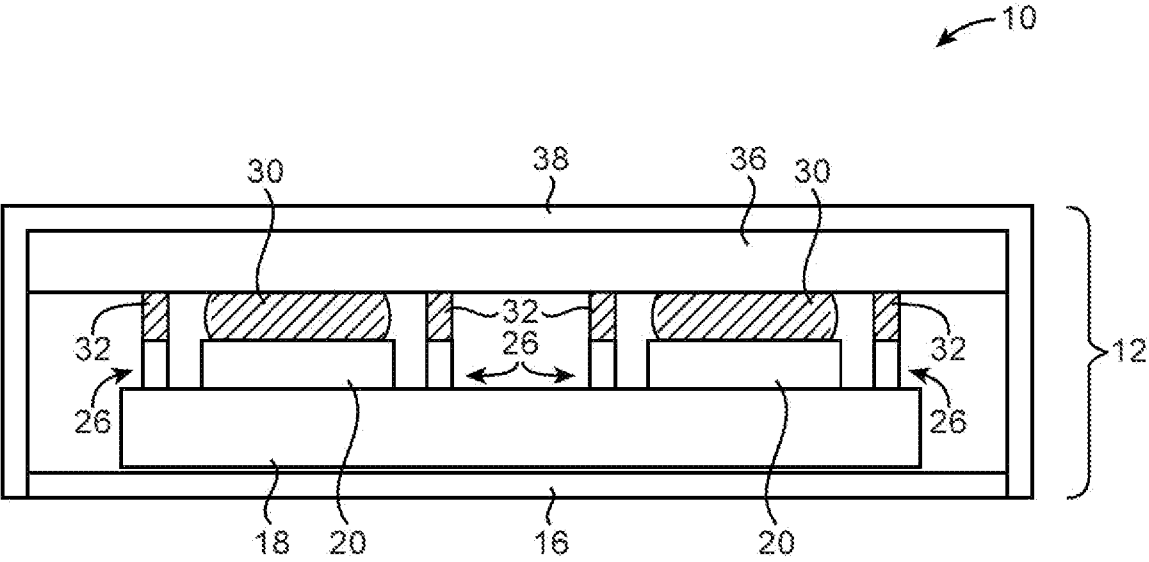


FIG. 4

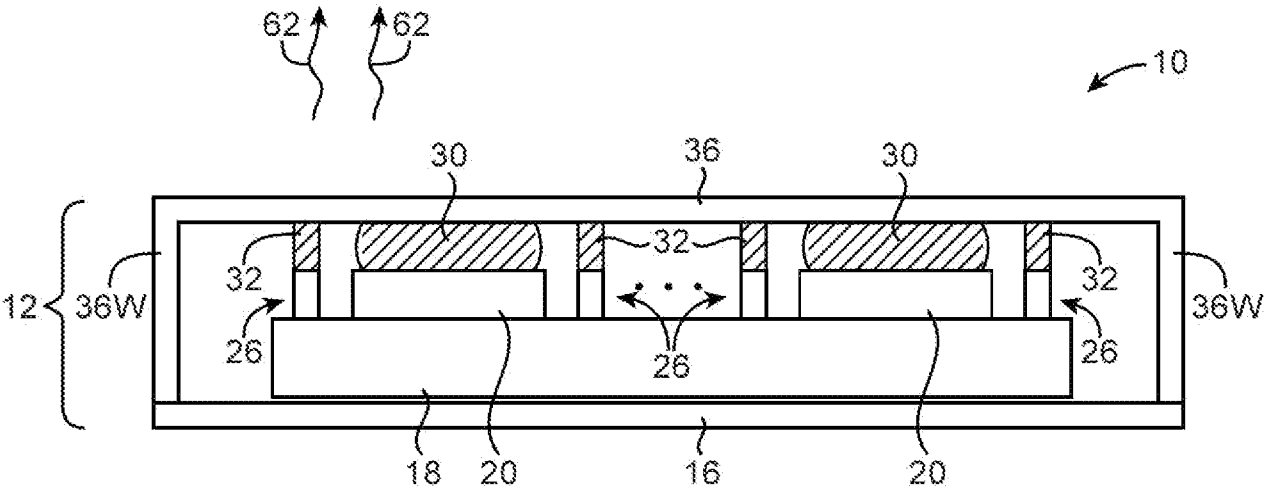


FIG. 5

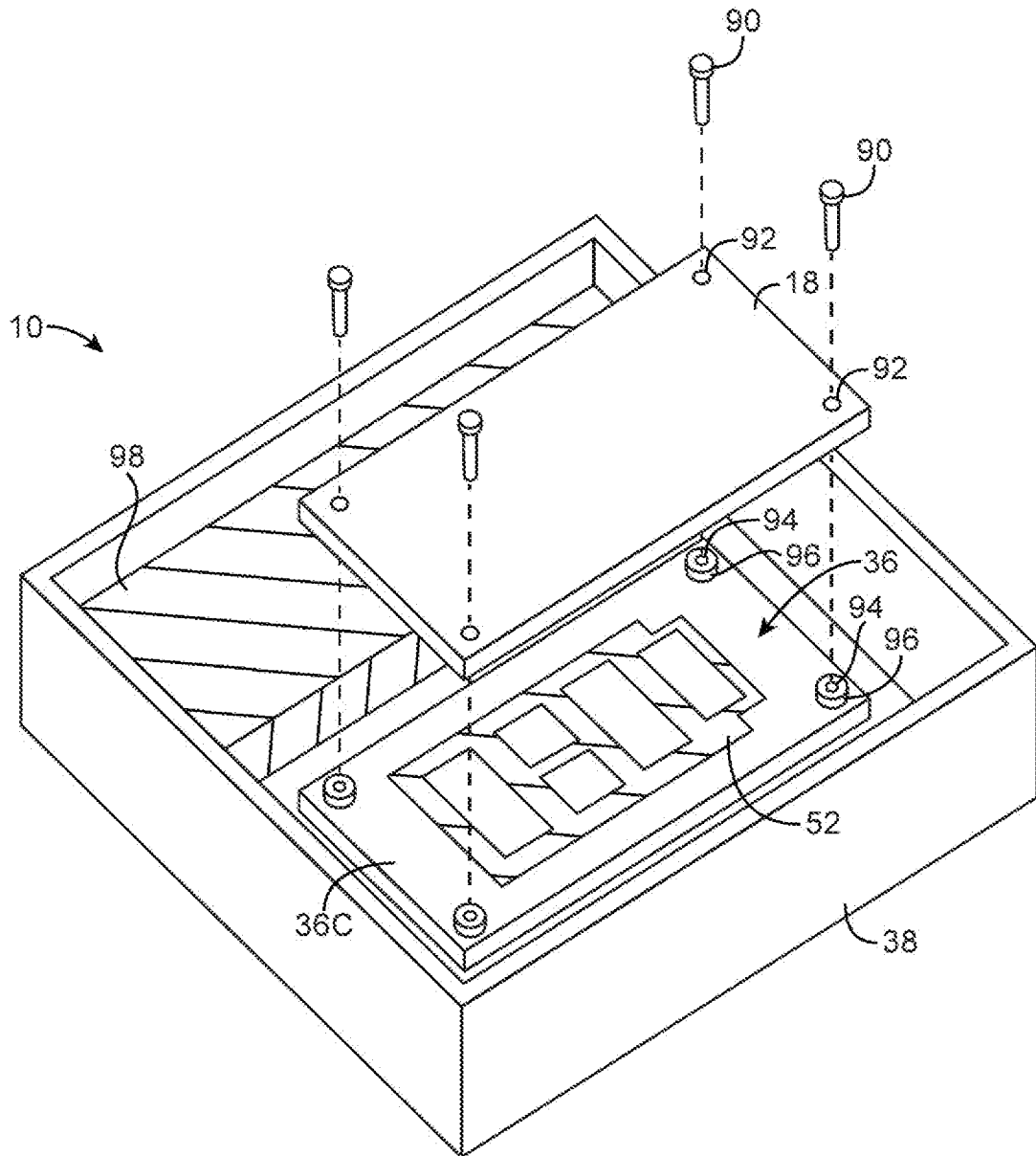


FIG. 6

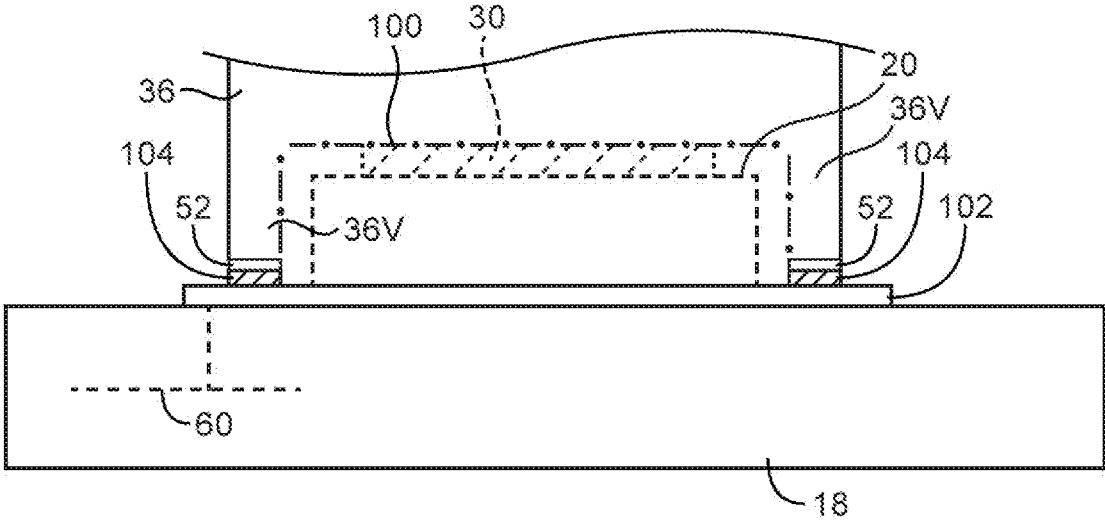


FIG. 7

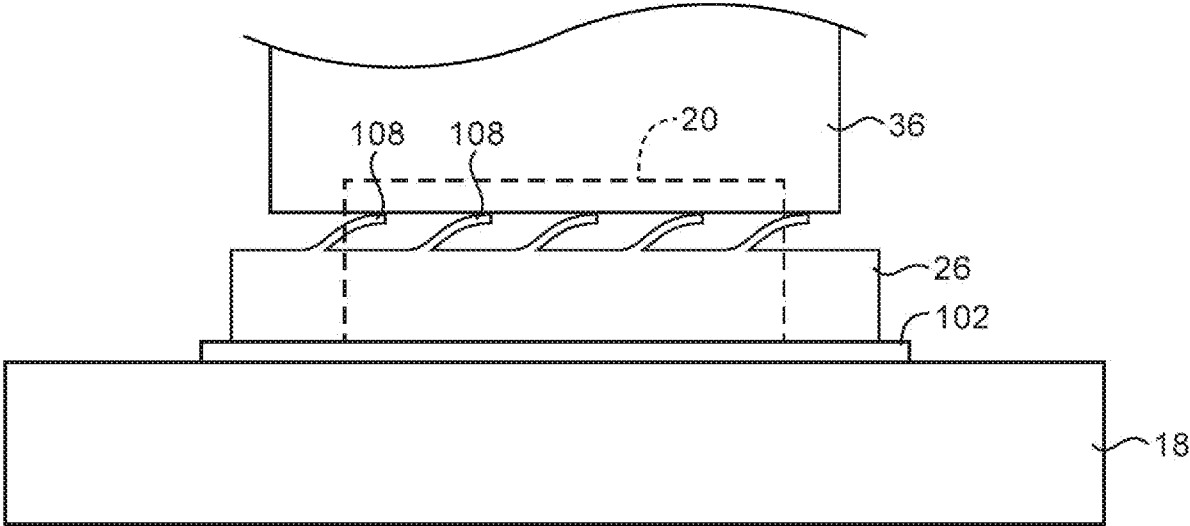


FIG. 8



INTERNATIONAL SEARCH REPORT

International application No
PCT/US2013/050737

A. CLASSIFICATION OF SUBJECT MATTER

INV. H01L23/10 H01L23/34 H01L23/40 H01L23/552
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H01L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP H09 27576 A (NEC CORP) 28 January 1997 (1997-01-28) paragraphs [0018], [0023], [0025]; figures 1,3 -----	1-4, 14



Further documents are listed in the continuation of Box C.



See patent family annex.

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

19 September 2013

Date of mailing of the international search report

03/12/2013

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/050737

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-4, 14

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2013/050737

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP H0927576	A	28-01-1997	NONE

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-4, 14

The subject matter of independent product claims 1 and dependent claims 2 and 3 is not inventive compared to the teaching of document JP H09 27576 (D1) and cannot therefore serve as a common concept for the dependent claims.

D1 discloses:

(re. claim 1):

An electronic device, comprising (figs. 1 and 3; abstract; par. 23 and 25) :

a dielectric substrate (4; PCB);

at least one electrical component (3) mounted on the dielectric substrate; and

a heat spreader structure (1) that is configured to dissipate heat from the electrical component and that is configured to serve as part of an electromagnetic interference shield for the electrical component.

D1 already discloses:

(re. claim 2):

the heat spreader structure (1) is shorted (7) to the metal fence (2) and

(re. claim 3): a conductive gasket (7) that is interposed between the heat spreader structure (1) and the metal fence (2) and that electrically shorts the structure to the metal frame.

The subject matter of claims 1-3 differs from the disclosure of D1 in that D1 does not explicitly disclose the heat spreading structure to be a metal. This is not inventive as the skilled person is well aware that the heat sink (1) in D1 can be one of a metal or a ceramic and since the heatsink has to be electromagnetically shielding in D1 (par. 18) the skilled person would choose a metal and therefore no inventive skill would be required to determine that the heatsink can be made of a metal.

As a consequence of the above, the following claimed separate sub-invention groups within group I have been identified in the sense of Rule 13(2) PCT:

Group Ia: Claims 1-4 (c.f. claim 4) and 14

Re. cl. 4 the surplus technical features with respect to the not inventive subject matter of claim 3 is that the conductive gasket comprises a conductive material selected from the group consisting of: conductive foam, conductive fabric, and conductive adhesive.

As all of the features of claim 4 are known from D1 none of them can form a contribution over the known prior art. The subject matter of dependent claim 4 is disclosed in D1 where the conductive gasket (7) comprises a conductive material consisting of conductive adhesive (par. 27).

Although the surplus technical features of the dependent claim 14 are not the same, they could be searched without any additional effort and thus they form the basis of the 1st searched invention. D1 discloses the dielectric

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

substrate (4) comprises a printed circuit (par. 23).

2. claims: 5-9

Group Ib: Claims 5-9 (c.f. claim 5)

Re. cl. 5 the surplus technical feature with respect to the not inventive subject matter of claim 3 is that the metal heat spreader structure comprises aluminum coated with aluminum oxide, wherein the aluminum has an exposed portion that is free of the aluminum oxide, and wherein the conductive gasket electrically shorts the metal frame to the exposed portion.

Thus the problem of claim 5 to be solved can be construed as: selecting the appropriate metallic heat sink material.

3. claim: 10

Group Ic: Claim 10

Re. cl. 10 the surplus technical feature with respect to the not inventive subject matter of claim 2 is that solder pads on the dielectric substrate and solder with which the metal fence is soldered to the solder pads.

Thus the problem of claim 10 to be solved can be construed as: finding the appropriate method to attach the metal fence to the dielectric substrate.

4. claim: 11

Group Id: Claim 11

Re. cl. 11 the surplus technical feature with respect to the not inventive subject matter of claim 2 is that the dielectric substrate comprises holes, the electronic device further comprising screws with which the substrate is attached to the metal heat spreader structure.

Thus the problem of claim 11 to be solved can be construed as: ensuring the substrate is mechanically attached to the heat sink (see application page 11, lines 5-20).

5. claim: 12

Group Ie: Claim 12

Re. cl. 12 the surplus technical feature with respect to the not inventive subject matter of claim 2 is that the metal fence comprises protruding portions that contact the metal heat spreader structure.

Thus the problem of claim 12 to be solved can be construed as: ensuring that the metal fence structure and the metal heat sink together provide optimal shielding properties (see application page 12, line 23-33).

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

6. claim: 13

Group If: Claim 13

Re. cl. 13 the surplus technical feature with respect to the not inventive subject matter of claim 2 is that the metal heat spreader structure has a recess that is configured to receive at least part of the electrical component.

Thus the problem of claim 13 to be solved can be construed as: ensuring the maximum heat dissipation between the chip and the heat sink.

7. claim: 15

Group Ig: Claim 15

Re. cl. 15 the surplus technical feature with respect to the not inventive subject matter of claim 1 is that the component comprises a radio-frequency transceiver integrated circuit.

Thus the problem of claim 15 to be solved can be construed as: defining the component in order to be able to perform additional functions (see application page 6, lines 11-27).

8. claims: 16-19

Group II

The surplus technical features of claim 16 (surplus to those of the non inventive common concept between claims 1 and 16) are that the component is an integrated circuit; the heat spreading structure has a recess that covers the integrated circuit; at least one metal trace on the substrate; and solder that solders the metal heat spreading structure to the metal trace.

Thus the problem of claim 16 to be solved can be construed as: Defining an integrated circuit -based package where the thickness of the package is minimised.

9. claims: 20-22

Group III

The surplus technical features of claim 20 (surplus to those of the non inventive common concept between claims 1 and 20) are that the component is an integrated circuit; the substrate is a printed circuit having solder pads; a metal fence structure is soldered to the solder pads, wherein the metal fence structure has an opening that overlaps the integrated circuit; a thermally conductive layer of material in the opening that contacts the integrated circuit; and the metal heat sink structure that contacts the thermally conductive layer of material.

Thus the problem of claim 20 to be solved can be construed as: ensuring the minimum number of physical components to be used whilst ensuring that the integrated circuit has its own

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

housing (see application, page 10, line 27-page 11, line 4)
