# APPLICATION OF CONDUCTIVE VIA OR TRENCH FOR INTRA MODULE EMI SHIELDING

## BACKGROUND

### Technical Field

The present invention is directed to semiconductor device packages and, more particularly, to electromagnetic and/or radio frequency interference shielding for semiconductor devices.

### Description of Related Technology

There exists a general desire in radio frequency (RF) communication systems for RF devices to be isolated from electromagnetic (radio frequency) interference (EMI) generated by other RF devices to maintain proper device performance. Similarly, the RF devices generally should be isolated from the electromagnetic interference received from, or transmitted to, the environment.

The traditional method of isolating RF devices from such electromagnetic interference is to cover the RF device with a grounded metal enclosure typically called a "can." However, this solution is costly and lacks design flexibility. In addition, the metal can add significant size to the device footprint on a printed circuit board, and also adds weight to the printed circuit board.

## SUMMARY

In accordance with one aspect, there is provided a packaged semiconductor module having an integrated electromagnetic interference. The packaged semiconductor module comprises a substrate having a ground plane, an electronic device mounted on a surface of the substrate, a bond pad disposed on the surface of the substrate and electrically connected to the ground plane, a mold compound covering the electronic device, a conductive post disposed on a side of the electronic device, the conductive post extending from the bond pad and at least partially through the mold compound, and a conductive layer disposed on the mold compound and electrically coupled to the conductive post and to the ground plane, the conductive post, the conductive layer, and the ground plane together forming the integrated electromagnetic interference shield, the conductive post extending from the bond pad to the conductive layer in a direction

perpendicular to a plane defined by the surface of the substrate, the packaged semiconductor module further comprising a plurality of electronic devices mounted on the surface of the substrate and only a single conductive post disposed between two of the plurality of electronic devices.

In some ~~embodiments~~examples, the conductive layer is disposed on a top and sides of the mold compound.

In some examples~~embodiments~~, the conductive layer physically contacts the ground plane on a side of the mold compound.

In some examples~~embodiments~~, the conductive layer physically contacts the conductive post on the top of the mold compound.

In some examples~~embodiments~~, the conductive layer includes silver-filled epoxy.

In some examples~~embodiments~~, the electronic device is an RF device.

In some examples~~embodiments~~, the packaged semiconductor module further comprises a plurality of electronic devices mounted on the surface of the substrate and a plurality of conductive posts disposed between two of the plurality of electronic devices.

In some examples~~embodiments~~, the packaged semiconductor module further comprises a plurality of electronic devices mounted on the surface of the substrate and only a single conductive post disposed between two of the plurality of electronic devices.

In some examples~~embodiments~~, the packaged semiconductor module further comprises a plurality of conductive posts surrounding the electronic device.

In some examples~~embodiments~~, the packaged semiconductor module further comprises a conductive via disposed within the substrate and providing electrical connection between the bond pad and the ground plane.

In some examples~~embodiments~~, the conductive via is disposed directly below the conductive post.

In some examples~~embodiments~~, the conductive via is laterally displaced from the conductive post.

In accordance with another aspect, there is provided a method of forming a packaged semiconductor module having an integrated electromagnetic interference shield. The method comprises providing a substrate having a ground plane, mounting an electronic device on a surface of the substrate, forming a bond pad on the surface of the substrate and electrically connected to the ground plane, depositing a mold compound on the electronic device, ablating a via opening in the mold compound on a side of the electronic device, ablating the via opening exposing an upper side of the bond pad, forming a conductive post within the via opening and in electrical contact with the bond pad, ~~and~~ depositing a conductive layer on the mold compound and in physical contact with the conductive post and with the ground plane, the conductive post, the conductive

layer, and the ground plane together forming the integrated electromagnetic interference shield, the conductive post extending from the bond pad to the conductive layer in a direction perpendicular to a plane defined by the surface of the substrate; and mounting a plurality of electronic devices on the surface of the substrate, wherein forming a conductive post further comprises forming a single conductive post between two of the plurality of electronic devices.

In some examples~~embodiments~~, forming the conductive post within the via opening includes depositing a solder paste within the via opening.

In some examples~~embodiments~~, forming the conductive post within the via opening includes forming the conductive post by electroplating.

In some examples~~embodiments~~, forming the conductive post within the via opening includes forming the conductive post by physical vapor deposition.

In some examples~~embodiments~~, the method further comprises mounting a plurality of electronic devices on the surface of the substrate.

In some examples~~embodiments~~, forming the conductive post incudes forming a plurality of conductive posts between two of the plurality of electronic devices.

In some examples~~embodiments~~, depositing the conductive layer on the mold compound includes depositing the conductive layer on a top and on sides of the mold compound.

In some examples~~embodiments~~, depositing the conductive layer on the mold compound includes depositing the conductive layer in physical contact with the ground plane on a side of the mold compound.

## BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of this disclosure will now be described, by way of non-limiting example, with reference to the accompanying drawings.

FIG. 1 is a flow diagram illustrating one example of a method of providing an integrated EMI shield as part of a packaging process;

FIG. 2 is a diagram of one example of an electronic module comprising a substrate and one or more dies mounted thereto;

FIG. 3 is a diagram of one example of a device package incorporating an integrated EMI shield;

FIG. 4 is a plan view of a portion of a device package including a continuous wirebond track; and

FIG. 5 is a plan view of an example of an electronic module illustrating relative placements of devices or die and conductive posts.

CLAIMS

1. A packaged semiconductor module having an integrated electromagnetic interference shield comprising:

a substrate having a ground plane;

an electronic device mounted on a surface of the substrate;

a bond pad disposed on the surface of the substrate and electrically connected to the ground plane;

a mold compound covering the electronic device;

a conductive post disposed on a side of the electronic device, the conductive post extending from the bond pad and at least partially through the mold compound; and

a conductive layer disposed on the mold compound and electrically coupled to the conductive post and to the ground plane, the conductive post, the conductive layer, and the ground plane together forming the integrated electromagnetic interference shield, the conductive post extending from the bond pad to the conductive layer in a direction perpendicular to a plane defined by the surface of the substrate;

the packaged semiconductor module further comprising a plurality of electronic devices mounted on the surface of the substrate and only a single conductive post disposed between two of the plurality of electronic devices.

2. The packaged semiconductor module of claim 1 wherein the conductive layer is disposed on a top and sides of the mold compound.

3. The packaged semiconductor module of claim 1 wherein the conductive layer physically contacts the ground plane on a side of the mold compound.

4. The packaged semiconductor module of claim 1 wherein the conductive layer physically contacts the conductive post on ~~the~~ a top of the mold compound.

5. The packaged semiconductor module of claim 1 wherein the conductive layer includes silver-filled epoxy.

6. The packaged semiconductor module of claim 1 wherein the electronic device is an RF device.

7. The packaged semiconductor module of claim 1 further comprising ~~a plurality of electronic devices mounted on the surface of the substrate and~~ a plurality of conductive posts disposed between two of the plurality of electronic devices.

~~8. The packaged semiconductor module of claim 1 further comprising a plurality of electronic devices mounted on the surface of the substrate and only a single conductive post disposed between two of the plurality of electronic devices.~~

~~9~~8. The packaged semiconductor module of claim 1 further comprising a plurality of conductive posts surrounding the electronic device.

~~10~~9. The packaged semiconductor module of claim 1 further comprising a conductive via disposed within the substrate and providing electrical connection between the bond pad and the ground plane.

~~11~~10. The packaged semiconductor module of claim ~~10~~ 9 wherein the conductive via is disposed directly below the conductive post.

~~12~~11. The packaged semiconductor module of claim ~~10~~ 9 wherein the conductive via is laterally displaced from the conductive post.

~~13~~12. A method of forming a packaged semiconductor module having an integrated electromagnetic interference shield, the method comprising:

providing a substrate having a ground plane;

mounting an electronic device on a surface of the substrate;

forming a bond pad on the surface of the substrate and electrically connected to the ground plane;

depositing a mold compound on the electronic device;

ablating a via opening in the mold compound on a side of the electronic device, ablating the via opening exposing an upper side of the bond pad;

forming a conductive post within the via opening and in electrical contact with the bond pad; ~~and~~

depositing a conductive layer on the mold compound and in physical contact with the conductive post and with the ground plane, the conductive post, the conductive layer, and the ground plane together forming the integrated electromagnetic interference shield, the conductive post extending from the bond pad to the conductive layer in a direction perpendicular to a plane defined by the surface of the substrate; and

mounting a plurality of electronic devices on the surface of the substrate, wherein forming a conductive post further comprises forming a single conductive post between two of the plurality of electronic devices.

~~14~~13. The method of claim ~~13~~ 12 wherein forming the conductive post within the via opening includes depositing a solder paste within the via opening.

~~15~~14. The method of claim ~~13~~ 12 wherein forming the conductive post within the via opening includes forming the conductive post by electroplating.

~~16~~15. The method of claim ~~13~~ 12 wherein forming the conductive post within the via opening includes forming the conductive post by physical vapor deposition.

~~17. The method of claim 13 further comprising mounting a plurality of electronic devices on the surface of the substrate.~~

~~18~~16. The method of claim ~~17~~ 12 wherein forming the conductive post incudes forming a plurality of conductive posts between two of the plurality of electronic devices.

~~19~~17. The method of claim ~~13~~ 12 wherein depositing the conductive layer on the mold compound includes depositing the conductive layer on a top and on sides of the mold compound.

~~20~~18. The method of claim ~~19~~ 17 wherein depositing the conductive layer on the mold compound includes depositing the conductive layer in physical contact with the ground plane on a side of the mold compound.