# CHIP SUPPORT OF A LEAD FRAME FOR AN INTEGRATED CIRCUIT PACKAGE

## Field of the invention

The present invention relates to packaging integrated circuits, and in particular to how an integrated circuit can be packaged such that wire bonds can be reliably formed from certain contacts of the integrated circuit to a body which is at a ground potential. The invention provides packaging methods, lead frames for use in the method, and integrated circuit packages produced by the method.

## Background of Invention

The term integrated circuits as in this document refers to dies, usually consisting substantially of semiconductor material, having electrical contacts formed in their upper surface. During a packaging process, the dies are embedded in a resin body from which electrically conductive leads extend.

A known packaging method is illustrated in Fig. 1, which consists of Figs. 1(a) and 1(b). Fig. 1(a) is a top of a central portion 1 of a lead frame, while Fig. 1(b) is a cross-sectional view in the line A-A. The central portion 1 of the lead frame is made of a conductive material. For example, it may be a copper plate. The lead frame includes further portions (not shown) outside the region 1, including leads. An integrated circuit 3 is adhered on a "die pad" area within the portion 1. The integrated circuit 3 includes electrical contacts on its surface which is uppermost in Fig. 1(b). Certain of these electrical contacts of the chip are bonded by wire bonds (not shown) to respective ones of the leads. However, certain of the contacts 5 of the integrated circuit 3 are to be connected to ground. To do this, the central portion 1 of the lead frame is connected to ground, and wire bonds 7 are formed between respective ones

of the contacts 5 and the copper 1. In general, it is found that the adhesion of the wire bonds 7 with the copper 1 is not adequate, and therefore silver regions 9 are plated in the locations of the copper 1 where the wire bonds 7 terminate. Subsequently, the integrated circuit 3, wire bonds 7 and silver plated regions 9 are encased in resin. During the same resin moulding process, the wire bonds (not shown) between the integrated circuit 3 and the leads (not shown) are encased in a resin body.

This process suffers from a number of problems. A first is that, in subsequent use of the device, the resin body may delaminate from the portion 1 of the lead frame. This delamination propagates rapidly across the surface of the portion 1, and can cause the wires 7 to be torn from the silver plating 9.

A second problem is that, when the integrated circuit 3 is adhered to the portion 1 of the lead frame, the adhesive may leak from beneath the integrated circuit 3 and cover some of the regions of silver plating 9. In this case, it may be impossible to form reliable wire bonds 7 to the regions of silver plating 9.

A third problem is that, since the regions 9 of silver plating are arranged to coincide with the locations of the contacts 5 on the integrated circuit 3, the silver plated lead frame must be designed using knowledge of the integrated circuit 3. In other words, different sorts of lead frames are required for packaging different sorts of integrated circuit 3. This reduces the flexibility of the packaging process. Packaging many sorts of integrated circuit requires a corresponding number of types of lead frame. This problem is addressed by a second known packaging process shown in Fig. 2(a) and 2(b). Elements in these figures which correspond to those of Fig. 1 are shown by the same reference numerals. The process differs from that of Fig. 1 only in that regions 9 are replaced by a ring 11 of silver plating on a laterally outward portion of

the portion 1 of the lead frame. The wire bonds 7 of Fig. 1 are replaced by wire bonds 13 between the contacts 5 and the ring 11. Thus, a wide variety of different types of integrated circuit 3 can be packaged with the same type of lead frame. Unfortunately, this arrangement suffers from the problem that, in order that the die pad area is able to accommodate integrated circuits of varying size, the ring 11 is laterally outward compared to the region 9, so when the integrated circuit 3 is relatively small the wires 13 must be much longer than the wires 7 in the arrangement of Fig. 1. Furthermore, adhesion of the resin to the silver plating tends to be less than between the resin and the copper, so the arrangement of Fig. 2, in which a larger proportion of the surface of the portion 1 of the leadframe is covered by silver plating 11, suffers from a higher risk of delamination between the resin and the lead frame.

## Summary of the Invention

The present invention aims to provide new and useful techniques for packaging integrated circuits, and new and useful packaged integrated circuits. In particular, the invention aims to provide integrated circuit packages in which the wires are less liable to lose electrical contact with the central grounded portion of the lead frame.

In general terms, the invention proposes that the central region of the lead frame is selectively etched to leave upstanding portions. Subsequently, during the packaging process, wires are formed between the upstanding portions of the leadframe and the contacts of the integrated circuit which are to be grounded. Subsequently, the wires and upstanding portions of the leadframe are encased in resin.

Since the upstanding portions of the lead frame are encased in resin, the attachment of the resin to the lead frame is much improved. In the first place

this is because the area of the lead frame which is in contact with the resin is increased (since it includes the sides of the upstanding portions). Furthermore, a mechanical locking is provided, so that the attachment of the resin to the lead frame does not have to rely on adhesion between the resin and the copper. This mechanical locking is particularly great if the surfaces of the upstanding portions are concave: a shape which normally arises automatically in the etching process.

Furthermore, any delamination which occurs between the resin and the lead frame cannot propagate easily up the sides of the upstanding portions as far as the wires. Thus, the wires are much less likely to be torn from the lead frame.

Furthermore, even if adhesive leaks from under the integrated circuit when the integrated circuit is mounted on the leadframe, it is most unlikely that it could cover any part of the upper surface of the upstanding portions of the lead frame.

As in known designs, silver is preferably plated onto the upper surface of the upstanding portions of the lead frame.

Specifically, a first expression of the invention is a leadframe for packaging an integrated circuit, the leadframe including a central portion which is formed of conductive material and which includes a die pad area for attachment of a lead frame, the central portion of the lead frame including one or more upstanding portions in electrical contact with the die pad area and for attachment to contacts of the leadframe which are to be grounded.

A second expression of a method of packaging an integrated circuit including:

locating an integrated circuit on the die pad area of such a lead frame;

forming wires between one or more electrical contacts of the integrated circuit and the upstanding portions of the lead frame, and

encapsulating the integrated circuit, wires and the upstanding portions of the lead frame in a resin body.

A third aspect of the invention is an integrated circuit package including:

an integrated circuit located at a die pad portion of a conductive body having upstanding portions;

wire bonds between at least one electrical contact of the integrated circuit and a respective one of the upstanding portions; and

a resin body encapsulating the wire bonds.

Brief Description of The Figures

Preferred features of the invention will now be described, for the sake of illustration only, with reference to the following figures in which:

Fig. 1, which is composed of Figs. 1(a) and 1(b), illustrates a stage of a first known packaging technique;

Fig. 2, which is composed of Figs. 2(a) and 2(b), illustrates a stage of a second known packaging technique;

Fig. 3, which is composed of Figs. 3(a) to 3(c), is three views of a lead frame which is a first embodiment of the invention;

Fig. 4, which is composed of Figs. 4(a) and 4(b), shows steps in the formation of the lead frame of Fig. 3;

Fig. 5, which is composed of Figs. 5(a) and 5(b), shows steps in a packaging process using the lead frame of Fig. 3;

Fig. 6, which is composed of Figs. 6(a) to 6(c) is three views of a lead frame which is a first embodiment of the invention;

Fig. 7, which is composed of Figs. 7(a) to 7(h), shows four further lead frames which are embodiments of the invention;

Fig. 8, which is composed of Figs. 8(a) to 8(d) is four views of a lead frame which is a sixth embodiment of the invention;

Fig. 9, which is composed of Figs. 9(a) to 9(j) shows five further lead frames which are embodiments of the invention.

Detailed Description of the embodiments

Referring to Fig. 3, a central portion of a lead frame which is a first embodiment of the invention is illustrated. Fig. 3(a) is a top view, Fig. 3(b) is a sectional view in the line A-A, and Fig. 3(c) is an enlarged view of the portion of marked "detail " in Fig. 3(b). The lead frame has a central portion 101, and further portions (not shown) which are located to the sides of the central portion 101. These further portions of the lead frame are according to conventional designs, and typically include leads which extend in a plane parallel to the major surface of the portion 101. The tips of the leads are for wire bonding to respective contacts of an integrated circuit which is mounted on a die pad region at the centre of the central portion 101 of the lead frame. Subsequently, in the moulding operation described below, these wire bonds are encased in resin, and then the leads are cut to leave portions of them extending to the sides of the resin portion, or indeed out of it, so that the leads can be connected for further circuitry. All these features may be according to any conventional design.

The central portion 101 of the lead frame is composed of a copper plate 102 and portions 104 upstanding from the plate. The upstanding portions 104 are referred to here as "pedestals". Each of the pedestals 104 has a layer of silver plating 109 on its upper surface. Thus, the silver plating 109, the

corresponding pedestal 104 and the copper plate 102 are in electrical contact with each other.

As shown in Fig. 3(c), the pedestal 104 is slightly inward from the edge 106 of the copper plate 102 by a distance "D". The pedestal 104 has concave walls 108.

The formation process of the portion 101 of the lead frame is shown in Fig. 4, which, for simplicity, shows only the parts of the structure which will become the structure of Fig. 3(c). To begin with, as shown in Fig. 4(a), a copper plate 110 of thickness of about 200 $\mu$m is coated with mask elements 112 (e.g. of a material which is commonly used in this field for masking portions of the lead frame which are to become leads) in locations corresponding to those of the pedestals 104 in the structure of Fig. 3(c). Then the leadframe is etched, removing a top layer of the plate 110 of a thickness about 100 $\mu$m. That is, the thickness of the plate 110 is approximately halved. The regions of the plate 110 protected by the mark elements 112 are not etched, and thus the copper underneath them forms pedestals 104 of a height about 100 $\mu$m (in other possible forms of the invention the pedestals may have differing heights, but they are typically in the range 50 $\mu$m to 150 $\mu$m). Thus, the structure of Fig. 4(b) is formed. The mask elements 112 are then removed, and the tops of the pedestals 104 are plated with silver to form the structure of Fig. 3(c). Note that the etching of the plate 110 is typically performed at the same time as a known etching step, performed on the portions of the lead frame which are outward of the central portion 101 of the lead frame, in which the leads are formed.

The use of the lead frame of Fig. 1 is illustrated in Fig. 5. In Fig. 5(a), an integrated circuit 103 is placed on the lead frame, and preferably adhered there. The adhesive layer 114 is lower than tops of the pedestals 104, so even if adhesive 116 leaks out, it cannot reach the tops of the pedestals 104.

The lead frame has certain contacts 105 which are to be connected to ground potential, and wire bonds 107 are formed from these to the silver portions 109. This is typically done at the same time as wires are formed between other of the contacts of the integrated circuit and the leads of the lead frame. Then, as shown in Fig. 5(b), a resin body 116 is moulded, so that the integrated circuit 103, the wire bonds 107 and pedestals 104, are encased in the resin 116. Typically, the wires (not shown) between the other contacts of the integrated circuit 103 and the leads are encased in the same resin body 116 at the same time. The pedestals 104 provide mechanical locking between the resin 116 and the plate 110, especially because of the concave surfaces 108. Further locking is provided by the concave surfaces 106 of the plate 102 produced during the etching. Even if delamination between the resin 116 and plate 102 does occur, it can only propagate easily along the top surface of the plate 102 (i.e. "laterally", that is horizontally as viewed in Fig. 3(c)), not up the sides of the pedestals 104. Therefore, there is little chance of the wires 107 being torn from the silver plating 109. Thus, a reliable electrical contact is provided between the contacts 105 and the plate 102, which in use is connected to ground (e.g. attached to a grounded area of a printed circuit board).

Fig. 6(a) to 6(c) are views of a second lead frame 201 according to the invention. Elements of the lead frame 201 corresponding to those of the lead frame 101 of Fig. 3 are given reference numbers 100 higher. The difference between the lead frames 101 and 201 is that the pedestals 204 extend to the edge 206 of the copper plate 202. The fabrication process, and use, of the central portion of the lead frame 201 is as explained above with reference to Figs. 4 and 5, but with different positions of the mask elements.

Figs. 7(a) and 7(b) are views of a third lead frame 301 according to the invention. Elements of the lead frame 301 corresponding to those of the lead frame 101 of Fig. 3 are given reference numbers 200 higher. The pedestals

304 are much shorter than the pedestals 104, 204 in the direction along the corresponding side of the copper plate 310. This can improve the mechanical interlocking of the resin body and the lead frame 301.

Figs. 7(c) and 7(d) are views of a fourth lead frame 401 according to the invention. Elements of the lead frame 401 corresponding to those of the lead frame 101 of Fig. 3 are given reference numbers 300 higher.

Figs. 7(e) and 7(f) are views of a fifth lead frame 501 according to the invention. Elements of the lead frame 501 corresponding to those of the lead frame 101 of Fig. 3 are given reference numbers 400 higher. In this case the pedestals 104 of Fig. 3 are replaced by a single pedestal 504 encircling the central portion of the plate 302 which is to receive the die. The top surface of the pedestal 504 is plated with silver 511, and thus forms a ring analogous to the ring 11 of Fig. 2. Compared to the first to fourth embodiments of the invention, the lead frame 501 is more flexible, in the sense that during the packaging wires can be formed from the contacts of the integrated circuit which are to be grounded to any locations along the sides of the central portion of the lead frame 501, whereas when providing wire bonds to the pedestals 104, 204, 304, 404 it is necessary to ensure that the wires extend to the correct locations along the sides of the central portion of the lead frame. The fabrication process, and use, of the central portion of the lead frame 701 is as explained above with reference to Figs. 4 and 5, but with different positions of the mask elements.

Figs. 7(g) and 7(h) are views of a central portion of a sixth lead frame 601 according to the invention. Elements of the lead frame 601 corresponding to those of the lead frame 501 are given reference numbers 100 higher. In this case, the ring 611 is located at the outer edge of the plate 602.

Figs. 8(a) to 8(d) are four views of part of a seventh lead frame 701 according to the invention. Fig. 8(a) is a top view. Fig. 8(b) is a sectional view in the line

A-A on Fig. 8(a). Fig. 8(c) is a sectional view of the portion of the lead frame 701 marked as "detail C" in Fig. 8(a), and Fig. 8(d) is a sectional view in the line B-B in Fig. 8(a). The lead frame 701 resembles the lead frame 301 of Fig. 7(a), so elements of Fig. 8 corresponding to those of Fig. 7(a) are labelled by reference numerals 400 higher. In contrast to the lead frame 301, the lead frame 701 has pedestals 704a, 704b along each side of the central portion in two groups. A first group of pedestals 704b are displaced by a first distance from the edge 706 of the central portion, while a second group of pedestals 704a are displaced inwardly from the edge 706 by a greater distance. There is a distance E between pairs of the pedestals 704a, and between pairs of the pedestals 704b, and a distance F between the groups 704a and 704b. Dimensions E and F may each be in the range 10 to 100 $\mu$m.

Figs. 9(a) and 9(b) are views of a central portion of a eighth lead frame 801 according to the invention. Fig. 9(b) is a view in the direction shown as A-A in Fig. 9(a). The lead frame 801 resembles the lead frame 401, but includes pedestals 804a which are spaced from the edge of the plate 802, and pedestals 804b which extend to the edges of the plate 802. Elements of the lead frame 801 corresponding to those of the lead frame 401 are given reference numbers 400 higher.

Figs. 9(c) and 9(d) are views of a central portion of a ninth lead frame 901 according to the invention. Fig. 9(d) is a view in the direction shown as A-A in Fig. 9(c). The lead frame 901 resembles the lead frame 101, but includes pedestals 904a, 904b at two distances from the sides of the lead frame 901. Elements of the lead frame 901 corresponding to those of the lead frame 101 are given reference numbers 800 higher.

Figs. 9(e) and 9(f) are views of a central portion of a tenth lead frame 1001 according to the invention. Fig. 9(f) is a view in the direction shown as A-A in Fig. 9(e). The lead frame 1001 resembles the lead frame 201, but includes

pedestals 1004a, 1004b at two distances from the sides of the lead frame 1001. Elements of the lead frame 1001 corresponding to those of the lead frame 201 are given reference numbers 800 higher.

Figs. 9(g) and 9(h) are views of a central portion of an eleventh lead frame 1101 according to the invention. Fig. 9(h) is a view in the direction shown as A-A in Fig. 9(g). The lead frame 1101 resembles the lead frame 501, but includes pedestals 1104a, 1104b at two distances from the sides of the lead frame 1101, supporting respective rings 1113a, 1113b. Elements of the lead frame 1101 corresponding to those of the lead frame 501 are given reference numbers 600 higher.

Figs. 9(i) and 9(j) are views of a central portion of an twelfth lead frame 1201 according to the invention. Fig. 9(j) is a view in the direction shown as A-A in Fig. 9(i). The lead frame 1201 resembles the lead frame 601, but includes pedestals 1204a, 1204b at two distances from the sides of the lead frame 1201, supporting respective rings 1213a, 1213b. Elements of the lead frame 1201 corresponding to those of the lead frame 601 are given reference numbers 600 higher.

Although only twelve embodiments of the invention have been described above in detail, many variations are possible within the scope of the invention as will be clear to a skilled reader.

Claims

1. A leadframe for packaging an integrated circuit, the leadframe including a central portion which is formed of conductive material and which includes a die pad area for attachment of an integrated circuit, the central portion of the lead frame including one or more upstanding portions in electrical contact with the die pad area and for attachment to contacts of the integrated circuit which are to be grounded, wherein surfaces of the one or more upstanding portions are concave and wherein the one or more upstanding portions are provided continually or continuously along the entire periphery of the central portion.

2. A leadframe according to claim 1 in which the upper surfaces of the upstanding portions of the lead frame are plated with silver.

3. A leadframe according to claim 1 in which each of upstanding portions are located at, or proximate to, one of the lateral sides of the central portion of the lead frame.

4. A leadframe according to claim 3 in which the upstanding portions of the lead frame which are at, or proximate to, at least one of the sides of the lead frame are in one or more groups, the upstanding portions of each group being at the same respective distance from the sides of the leadframe.

5. A lead frame according to claim 3 or claim 4 in which the upstanding portions at, or proximate to, at least one of the sides of the lead frame each extend continuously along at least half of the length of that side.

6. A method of forming a lead frame which includes selectively etching one surface of a central conductive portion of the lead frame to form one or more upstanding portions, wherein surfaces of the one or more upstanding portions are concave and wherein the one or more upstanding portions are provided continually or continuously along the entire periphery of the central conductive portion, and providing a layer of a conductive material onto the top surfaces of the upstanding portions.

7. A method of packaging an integrated circuit including:

locating an integrated circuit on the die pad area of a leadframe according to any of claims 1 to 5;

forming wires between one or more electrical contacts of the integrated circuit and the upstanding portions of the lead frame, and

encapsulating the integrated circuit, wires and the upstanding portions of the lead frame in a resin body.

8. An integrated circuit package including:

an integrated circuit located at a die pad portion of a conductive body having one or more upstanding portions, wherein surfaces of the one or more upstanding portions are concave and wherein the one or more upstanding portions are provided continually or continuously along the entire periphery of the die pad portion;

wire bonds between at least one electrical contact of the integrated circuit and a respective one of the upstanding portions; and

a resin body encapsulating the wire bonds.