

PATENT SPECIFICATION

1,165,609

DRAWINGS ATTACHED.

1,165,6



Date of Application (No. 54058/67) and filing Complete Specification: 28 Nov., 1967.

Application made in United States of America (No. 611,944) on 26 Jan., 1967.

Complete Specification Published: 1 Oct., 1969.

Index at acceptance:—**H1** K(351, 356, 35X, 36Y, 362, 368, 37Y, 37X, 38Y, 384, 385, 386, 389, 411, 421, 424, 43Y, 511, 53Y, 53X, 54Y, 55Y).

International Classification:—**H 01 L 1/00.**

COMPLETE SPECIFICATION.

Lead Frame Package for Semiconductor Devices and Method for Making Same.

We, ADVALLOY INC., a corporation organised and existing under the laws of the State of California, United States of America, of 1848 Bay Road, Palo Alto, California 94303, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to an improved package for mounting a semiconductor device within a lead frame and also to a method for assembling such packages in quantity.

In order to utilize semiconductor devices such as integrated circuit dice in electronic apparatus, they must be mounted or packaged so as to receive adequate support and protection and, in addition, they must be combined with some means to provide electrical paths to the terminals of the device. Prior to the present invention these requirements were accomplished by mounting the semiconductor device within a lead frame on a substrate member and thereafter interconnecting its terminals with the lead tips of the lead frame by means of very fine wire. While such a procedure was satisfactory to a degree, it generally required time-consuming and highly skilled labor and therefore was expensive and a restraint to large volume production and a lower unit cost. Also, these fine wires often were subject to breakage, particularly at their end connections to the lead frame and semiconductor terminals, thus seriously impairing the reliability of the product.

A general object of the present invention

[Price 4s. 6d.]

is to provide a combined semiconductor and lead frame package that solves the aforesaid problems.

According to one aspect of this invention there is provided a semiconductor package comprising a lower substrate member of non-conductive material having an upper recessed area, an intermediate connector chip fitted within said recessed area in a predetermined position and having a dielectric base portion, a series of electrically conductive paths on said connector chip arranged in a predetermined pattern extending inwardly from outer ends located near the edge of said connector chip and having inner terminals at spaced apart locations thereon, a semiconductor device mounted on said connector chip with its terminals in direct contact with said inner terminals, means providing a plurality of external lead members extending to within said substrate member and bonded to said conductive paths of said connector chip, and a top member located on and bonded to said substrate member while covering said connector chip.

The invention also provides a method of making a semiconductor package substantially as hereinafter described with reference to the accompanying drawings.

For a better understanding of the invention reference will now be made by way of example to the accompanying drawings in which:—

Figure 1 is an enlarged exploded view in perspective showing a semiconductor and lead frame package embodying the principles of the present invention,

Figure 2 is an enlarged end view in section of the package of Figure 1 as it appears in its completed form with the size of the various elements distorted in some instances to make them more visible.

Figures 3-5 are enlarged views showing somewhat schematically the progressive method steps for assembling our package according to the present invention.

Figure 3 is a view in perspective showing the first step of attaching a typical semiconductor device to a connector chip.

Figure 4 is a view in perspective showing the next step of placing the connector chip in a base member.

Figure 5 is a view in perspective showing progressively the final assembly of the combined semiconductor device, connector chip and base member with a lead frame according to the invention.

In the drawings, Figure 1 shows an exploded view of an integrated circuit package embodying the principles of the present invention, a unit that may be varied in its internal electronic circuitry and characteristics and yet can be assembled in large quantities by a unique combination of method steps as will be described later. In broad terms, the assembled package 20 comprises a lead frame 22 of relatively thin flexible material having a window 24 with opposite side and end edges. Extending inwardly from each of two opposite side or end edges in the embodiment shown are a series of lead portions 26 that terminate within the window area at predetermined spaced apart locations relative to each other. It is understood that the lead frame may have various configurations with any number of lead portions attached to or integral with the side and end portions.

Located within the window area of the lead frame is a substrate base member 28 of the package 20. This latter member may be rectangular in planform and is made of a suitable non-conductive plastic or ceramic material. Its function is to secure and maintain the lead bars in a proper spaced apart orientation and to provide a protective retaining body or housing for a much smaller integrated circuit die. This substrate base member 28 has a central recessed area 30 which forms ridgelike side and end portions 32 and 34. Any of these side or end portions may be castellated to provide spaced apart notches 36 of the desired dimensions and spacing to accommodate the lead portions 26 of the lead frame 22. When the substrate member 28 is properly positioned within the lead frame window, the lead portions extend inwardly beyond the side or end ridge portions a uniform predetermined amount.

Seated within the recessed area of the substrate base member is an intermediate

substrate unit or connector chip 38 to which the ends of the lead portions are attached. This intermediate connector unit is made of a non-conductive material such as a ceramic and is provided with a surface layer film of conductive material formed in a pattern that provides conductive paths as on integrated circuit devices from one or more of its sides inwardly toward the center of the connector chip. For example, in the embodiment shown, the paths 40 extend inwardly from opposite side edges of the connector chip 38 and terminate at contact points 42 arranged in a desired spaced apart pattern that is selected to be compatible with a terminal pattern on an integrated circuit die 44 to be attached. This latter die is fixed to the chip near or at the center thereof by a suitable bonding material with its terminals registered with and bonded to the contact points 42 of the connector chip. It is apparent that any form of integrated circuit die (or a plurality of dice) can be so mounted on the chip that has a surface pattern of conductive paths with contact points compatible therewith and also an overall shape compatible with the recessed area 30 of the substrate base member 28.

The intermediate connector chip 38 with its integrated circuit die fixed thereto may be held in position permanently within the substrate recess 30 by a suitable bonding material. Its orientation within and relative to the substrate member is assured by providing it with a planform shape which conforms to that of the recessed area on the substrate, so that it will fit therein only when in the proper position. For example, the connector chip may have a locator notch 46 which corresponds with a similar projection 48 within the recessed area.

The lead portions 26 extending from the lead frame 22 are secured to the side portions of the substrate member and preferably within the positioning notches 36, the ends of the lead portions being bonded electrically, as by welding, to the connector chip at the outer ends of the conductive paths 40 along opposite sides of the intermediate connector.

To complete the package and make it a fully enclosed unit, a cover 50, preferably of the same planform shape of the substrate base member 28, may be fixed thereto by suitable bonding material. Before the cover is placed in position additional potting material indicated by the numeral 52 in Figure 2 may be used to cover the intermediate chip and its integrated circuit die. With the cover in place, the finished package 20 is a completely insulated and protected unit from which extend the lead portions 26 that may then be connected to other components in an electronic system.

A unique method of assembly of our

semiconductor package 20 provides several advantages and will now be described with reference to Figures 3 to 5. Essentially, the method entails the joining together of the various components previously described so that the appropriate electrical connection points are aligned in direct contact to provide electrical continuity without the need for separate bonding wires and the like. The form of the individual components and their interrelationship makes it possible to assemble the packages 20 on a continuous conveyor line system utilizing the lead frames in strip form as a carrier device.

The first step of our method as shown in Figure 3 is to attach a semiconductor device such as an integrated circuit die 44 to the connector chip 38. In this step the die must be positioned with precision so that its terminals come into direct contact with the inner end terminals 42 of the conductive paths 40 on the connector chip. This may be accomplished rapidly and efficiently with suitable positioning devices available in the field of microelectronics. After the semiconductor device has been installed on the connector chip, this sub-assembly may be easily tested by appropriate equipment for electrical characteristics and continuity.

In the next step, shown in Figure 4 the pretested connector chip 38 with the integrated circuit die fixed thereto is placed in and bonded to the substrate base member 28. The locator notch 46 or an equivalent means assures the proper orientation of the connector chip within the base member.

In the third major step of our method for making a large plurality of the semiconductor package 20, as shown in Figure 5, a long flexible strip of integrally connected lead frames 22 is provided which may be conveniently supplied in a reel form. Essentially, each frame comprises a window in the strip in which extend an array of lead bars 26 having a predetermined width and spacing precisely equal to that of the conductive path ends along opposite sides of a connector chip previously installed in a substrate base member. Thus, when each lead frame is placed on a base member its lead bars or portions 26 automatically register and come in contact with the outer end pads 27 of these conductive paths on the connector member and are in position to be connected permanently. This latter step of electrically connecting the lead bars may be accomplished by various means, such as welding, either individually on each lead bar or on all of the lead bars simultaneously using suitable apparatus. After this, a suitable potting compound may be applied to the electrically connected lead bars and connector chip just before a protective top member 50 of non-conductive material having generally the same planform is

attached. The top member may be attached to the base member by means of a suitable bonding agent and the application of a relatively small amount of pressure when the package is supported in a platen. After completion of the aforesaid assembly steps, the packages can remain attached to the lead frame strip and can thus be rolled back into a reel form. This greatly facilitates handling and shipment and also the subsequent use by electronic component manufacturers.

Our package 20 provides several inherent advantages, an important one being the fact that it facilitates the use of lead frames having a simple configuration which can be combined with a wide variety of integrated circuit devices having terminals arranged in various patterns. It is understood that the particular lead frame which is shown having straight lead portions is merely illustrative and does not limit the invention. Also, the connector chip 38 with its surface film pattern of conductor paths whose outer ends are spaced to match the spacing of the lead portions of the lead frame can be easily manufactured with various surface film patterns so that the inner ends of its conductor paths will correspond to the terminal arrangements on a wide variety of integrated circuit dice. It is understood also that one connector chip may accommodate a multiplicity of integrated circuit dice. In all cases, the terminal connections between the integrated circuit die and the connector chip can be made permanently yet with comparative ease when these two components are bonded together, and this sub-assembly can be thoroughly tested for electrical characteristics before being connected to the lead frame. When the connector chip 38 is then placed with its substrate base member 28 in the desired position the lead portions can be easily aligned by it and bonded to their proper contacts. The end result is an unusually high productive yield of fully operable packages during the final assembly process.

It should be apparent from the foregoing that the present invention provides a semiconductor package and a method for making same that overcomes and eliminates several serious prior art problems in previous packages, such as the need to handle and make reliable connections between a large number of terminals with extremely fine wire. Thus, our package is not only more reliable but easier and more economical to manufacture.

WHAT WE CLAIM IS:—

1. A semiconductor package comprising a lower substrate member of non-conductive material having an upper recessed area, an

semiconductor package 20 provides several advantages and will now be described with reference to Figures 3 to 5. Essentially, the method entails the joining together of the various components previously described so that the appropriate electrical connection points are aligned in direct contact to provide electrical continuity without the need for separate bonding wires and the like. The form of the individual components and their interrelationship makes it possible to assemble the packages 20 on a continuous conveyor line system utilizing the lead frames in strip form as a carrier device.

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attached. The top member may be attached to the base member by means of a suitable bonding agent and the application of a relatively small amount of pressure when the package is supported in a platen. After completion of the aforesaid assembly steps, the packages can remain attached to the lead frame strip and can thus be rolled back into a reel form. This greatly facilitates handling and shipment and also the subsequent use by electronic component manufacturers.

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It should be apparent from the foregoing that the present invention provides a semiconductor package and a method for making same that overcomes and eliminates several serious prior art problems in previous packages, such as the need to handle and make reliable connections between a large number of terminals with extremely fine wire. Thus, our package is not only more reliable but easier and more economical to manufacture.

WHAT WE CLAIM IS:—

1. A semiconductor package comprising a lower substrate member of non-conductive material having an upper recessed area, an



intermediate connector chip fitted within said recessed area in a predetermined position and having a dielectric base portion, a series of electrically conductive paths on said connector chip arranged in a predetermined pattern extending inwardly from outer ends located near the edge of said connector chip and having inner terminals at spaced apart locations thereon, a semiconductor device mounted on said connector chip with its terminals in direct contact with said inner terminals, means providing a plurality of external lead members extending to within said substrate member and bonded to said conductive paths of said connector chip, and a top member located on and bonded to said substrate member while covering said connector chip.

2. A semiconductor package as claimed in Claim 1 wherein said means comprises a lead frame having a window larger than said lower substrate member with lead portions extending inwardly from the side edges thereof, said substrate member being located within the area of said window.

3. A semiconductor package as claimed in Claim 1 or 2 wherein said connector chip has substantially the same shape as said recessed area and fits therein in a predetermined position relative to said substrate.

4. A semiconductor package as claimed in Claim 2 or 3 wherein said recessed area forms opposite side ridges on said substrate member, and notches in said side ridges for receiving and supporting said lead portions of the lead frame in a spaced apart arrangement compatible with the spacing and location of the outer ends of said connector chip.

5. A semiconductor package as claimed

in Claim 2, 3 or 4 wherein said lead members extend outwardly from said connector chip between said top member and said base substrate member.

6. A semiconductor package as claimed in Claim 1 wherein said means comprises an elongated flexible carrier strip having spaced apart windows along its length, and a plurality of lead portions extending inwardly towards each other from opposite sides of each said window on said carrier strip

7. A semiconductor package as claimed in Claim 1 or 6 wherein said semiconductor device is an integrated circuit die fixed to said connector chip with its terminals in register and directly engaged with said inner contacts.

8. A semiconductor package as claimed in any one of the preceding Claims and including a potting compound encapsulating said intermediate connector chip, said substrate member and said lead portions connected to said chip.

9. A semiconductor package substantially as herein described with reference to and as shown in the accompanying drawings.

10. The method of making a semiconductor package substantially as herein described with reference to the accompanying drawings.

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