

The subject of the present invention is a device for inspection of soldering by electronic measurement of the area of the soldering, for example in the field of connection technology.

5 Connection, for example of packages or electronic components, to a printed-circuit substrate requires reliable soldered joints, that is to say joints which are sufficiently wide and thick so that good electrical contact is established and that the latter withstands,  
10 over time, the temperature variations and vibrations, for example.

This aspect is all the more important the harsher the environment of the circuit (military or space applications, for example).

15 Various techniques for inspecting the connections are known. For harsh-environment applications, a visual inspection, possibly with the aid of a binocular microscope is mainly employed. This technique has the drawback of being lengthy and expensive, of being limited in its effectiveness and, finally, of limiting the density of  
20 the circuits: the reason for this is that the components or the packages must be sufficiently far apart from each other to permit this visual inspection and, in addition, all the soldered joints produced must be visible, that is  
25 to say they must be located at the periphery of the packages or of the components; this appreciably increases the overall size thereof when the number of connections becomes large, this being the case especially for very-large-scale integrated circuits.

30 The subject of the present invention is a device for inspection of soldering by electronic measurement of the area of the soldering, which device, as defined by Claim 1, applied to connection technology, makes it possible to overcome previous limits.

35 Further objectives, characteristics and results of the invention will emerge from the following description, which is given by way of example and illustrated by the appended drawings which depict, in Figures 1 and 2, various embodiment variants.

In these various figures, on the one hand, the same references relate to the same elements, and, on the other hand, the actual scale has not been respected for the sake of clarity of the drawing.

5           Figure 1 depicts a variant of the device according to the invention.

          In this figure, the package 1 has been depicted diagrammatically as connected to the substrate 4, for example by two joints, one of which is designated by 50  
10           and connected to a lateral contact pad 60.

          In this embodiment, the substrate 4 carries an electrode 73 arranged so as to be placed beneath the package 1, therefore in the vicinity of the joint 50 to be tested. This electrode 73 is connected to a lateral  
15           contact pad 71 in a manner similar to the joint 50. The contact pad 60 is connected to a negative potential and the electrode 73, which acts in the same way as the electrode 7 of Figure 1, is connected via the contact pad  
20           71 and via a point contact 75 at a positive potential.

          The joint 50 then emits electrons and the current measured between the joint and the electrode 73 is representative of the lateral surface area of the joint.

          The point contact 8 is sheathed with an electrical insulation, for example of the shrinkable-sleeve type, in order to prevent parasitic emission of electrons, except at its tip of course. In a variant, the sleeve may have a size such that it also surrounds the  
25           contact pad 60 when the point contact 8 is applied to the latter, further decreasing the parasitic emission of  
30           electrons.

          The operation of the device according to the invention is as follows.

          The tested joint 50, connected via the elements 60 and 8 to a negative potential, therefore constitutes  
35           a cathode and emits electrons, this emission being proportional to its emissive surface area, namely its lateral surface area in this example. The electrons thus emitted, in part are captured directly by the electrode 73 acting as anode and, in part ionize the atoms of the

gas existing, where appropriate, between the tested joint and the anode 73; the electrons produced by the ionization are also collected by the anode 73. All these electrons create a current which is a function of the lateral area of the joint 50 under test, of the pressure of the gas present between the electrodes 73 and 50, of the voltage applied between the anode and the cathode and of the distance between these electrodes.

It is thus apparent that the measurement of the current gives a measurement of the surface area of the joint under test, the other parameters being fixed. The measurement of the surface area permits, in its turn, inspection of the quality of the soldered joint: the reason for this is that too great or too small a surface area, compared to values defined beforehand, indicates, respectively, a soldered joint which is too spread out, with the possible risk of short circuiting, or, on the contrary, a connection which is insufficient from the electrical and/or mechanical standpoint.

In an embodiment variant, in order to refine the current measurement and especially to overcome pressure fluctuations in the surrounding gas, the current emitted by an additional electrode (not depicted), serving as a standard, of known area, and preferably next to that of the joint under test, is measured periodically.

According to another embodiment variant, the polarity of the voltages applied is periodically reversed so as to employ the electrode 73 periodically as cathode; since the surface area of the electrode 73 is known, it may act as a standard: this procedure thus also makes it possible to standardize the current measurements. More generally, the voltage applied between cathode and anode may be DC or AC.

The device according to the invention also permits measurement of the volume of a soldered joint. In order to do this, the fact that the measured current is also a function of the voltage and of the distance between the electrodes is employed and, fixing the other parameters, the voltage is varied in order to know the

(average) distance between the electrodes. Knowing the distance between the anode and the substrate (4), the thickness of the joint and consequently its equivalent volume, since its lateral surface area is already known, are calculated therefrom. This complementary measurement is useful because the quality of a soldered joint is related to the quantity of material connecting the two parts.

Figure 2 depicts another embodiment variant, in which the negative potential is applied to the joint to be tested via the package.

In Figure 2, the package 1 is found to be connected up to the substrate 4 by two joints, one, designated by 50, is under test. By way of example, the positive electrode has been depicted according to the same embodiment as the previous figure, that is to say an electrode 73 arranged on the substrate 4 beneath the package 1.

In this variant, the package includes an upper contact pad 53 extending laterally down to the joint 50. The point contact 8 raised to the negative potential is then placed on the contact pad 53, thus raising the joint 50 to a negative potential.

The inspection device according to the invention makes it possible to inspect the quality of a soldered joint by measurement of its lateral surface area and of its equivalent volume, and this is so whether or not the soldering is visible, irrespective of the shape (plane, developable or crooked shape) of its surface area and irrespective of its application: soldering of a package (of the type known by the name Pad Grid Array, for example), of a component (of the type known by the name "flip chip", for example), or another item.

This inspection may be carried out by comparing the values obtained for each of the joints to be tested with a range of pre-established reference values, or alternatively, by successive measurement of all the surface areas of the soldered joints of one and the same set of joints, determining an average and eliminating the

extreme values.

This device is also applicable, for example, to the inspection of conductive patterns deposited on a substrate, especially by screen-printing.

5 It is further applicable, as illustrated in Figure 10, to the inspection of insulating patterns.

10 In this figure, an insulating substrate 90 has been depicted, on which substrate has been deposited an insulating pattern 91 whose area it is desired to inspect. For this purpose, a conducting pattern 93 of surface area similar to that of the pattern 91, and raised to a negative potential with the aid of a point contact 94, is arranged on the other side of the substrate 90. An electrode 92 connected to a negative  
15 potential is arranged above the pattern 91.

The function of the conducting pattern 93 is to make it possible to raise the surface of the insulating pattern 91 to a negative potential. The potential difference applied to the electrodes 92 and 93 is DC or AC.  
20 The operation of the device is then similar to that described previously.



CLAIMS

1. Device for inspection of soldering by electronic measurement of the area of the soldering, characterized in that, with the soldering forming a joint (50) between  
5 an electronic component package (1) and an interconnection substrate (4), the device includes an electrode (73) arranged on the substrate, beneath the package, and electrically connected to a first contact pad (71) arranged on the substrate at the periphery of  
10 the package, the first contact pad being raised to a first potential; in that the joint (50) is electrically connected to a second contact pad (60, 53) also arranged at the periphery of the package, and in that it furthermore includes means for raising the second contact pad,  
15 and consequently the joint, to a negative potential with respect to the first potential, so that the joint emits electrons whose number is a function of the area of the surface, and means for measuring the current between the surface and the electrode, the current being representative of the number of electrons and consequently of the  
20 area of the surface.
2. Device according to Claim 1, characterized in that the second contact pad (53) is arranged on the side of the package (1), in electrical contact with the joint  
25 (50).
3. Device according to Claim 1, characterized in that the second contact pad (60) is arranged on the substrate (4).