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A PICK AND PLACE CAP FOR AN ELECTRICAL CONNECTOR

Field

The invention relates to a pick and place cap for an electrical connector, an apparatus, a method and an electronic device.

Background

During the manufacture of electronic devices, some components are picked up from a magazine or tape & reel and placed on a circuit board to be soldered. During the pick and place operation the vacuum head of the pick and pack apparatus may apply suction to a surface of the component. However, some components do not have a suitable surface for the vacuum head.

One alternative is to temporarily attach a cap to the component, so that the vacuum head attaches to the cap during the pick and place operation. The cap can then be removed after placement or soldering. However a different cap may be required for each type of connector. Examples of prior art caps include Chinese patent publication number 2713682, US patent number 6561825 and US patent publication number 2004048495.

Summary

In general terms the invention proposes that a pick and place cap can be secured to an electrical connector with a plurality of ribs engaging the connector without touching contacts of the connector. This may have the advantage that the thermal expansion of the connector and the cap are matched, and that securement is not compromised by the different thermal expansion of the contacts. The cap may be configured to locate between two key portions of the connector. This may have the advantage that the cap may be secured to a plurality of types of electrical connector.

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In a first specific expression of the invention there is provided a pick and place cap comprising

a first jaw and a second jaw configured to extend over a row of connector contacts of an electrical connector when in an assembled configuration, the first jaw and the second jaw comprising at least one major external surface configured for attachment to a pick and place apparatus,

a plurality of ribs extending from the first jaw configured to engage portions of the electrical connector between the contacts and to be substantially spaced from the contacts when in the assembled configuration, and

at least one portion of the cap configured to engage between two key portions of the electrical connector to substantially locate the cap relative to the electrical connector when in the assembled configuration.

In a second specific expression of the invention there is provided an apparatus comprising:

an electrical connector , and

a cap according to the first specific expression, the cap configured for engagement with the connector.

In a third specific expression of the invention there is provided a method comprising:

picking up an electrical connector via a pick and place cap, the cap engaged with the connector, with a first jaw and a second jaw engaged over a row of connector contacts and a set of ribs extending from the first jaw with portions of the connector engaged between respective contacts whilst substantially avoiding contact between the ribs and respective contacts, and

placing the connector on a circuit board.

In a forth specific expression of the invention there is provided an electronic device manufactured according to the method in the third specific expression.

In a fifth specific expression of the invention there is provided a pick and place cap comprising:

a pick and place cap configured to mate with at least two different types of data storage connectors and comprising:

a first tooth for defining a location of the cap when the cap mates with the first type of data storage connector;

a different second tooth for defining a location of the cap when the cap mates with the second type of data storage connector; and

a plurality of insulative ribs, such that when the cap mates with each of the first and second types of data storage connectors, the plurality of the insulative ribs only engage areas between contacts of the data storage connector.

Brief description of the drawings

In order that the invention may be fully understood and readily put into practical effect there shall now be described by way of non-limitative example only, an example embodiment described below with reference to the accompanying illustrative drawings in which:

Figures 1(a) to 1(d) are perspective views of a first exemplary embodiment of a pick and place cap according to an aspect of the present invention attached to an electrical connector,

Figure 2 is a cross section of the perspective view in Figure 1(c),

Figures 3(a) to 3(d) are perspective views of the cap in Figure 1(c),

Figures 4(a) to 4(d) are perspective views of a second exemplary embodiment of a pick and place cap according to an aspect of the present invention attached to an electrical connector,

Figure 5 is a cross section of the perspective view in Figure 4(c),

Figures 6(a) to 6(d) are perspective views of a third exemplary embodiment of a pick and place cap according to an aspect of the present invention attached to an electrical connector,

Figure 7 is a cross section of the perspective view in Figure 6(c),

Figures 8(a) to 8(d) are perspective views of a forth exemplary embodiment of a pick and place cap according to an aspect of the present invention attached to an electrical connector,

Figure 9 is a cross section of the perspective view in Figure 8(c),

Figure 10 is a perspective view of a fifth exemplary embodiment of a pick and place cap according to an aspect of the present invention attached to an electrical connector, and

Figure 11 is a flow diagram of an exemplary embodiment of method according to an aspect of the present invention.

Detailed description

Figures 1(a) to 1(d) and 2 show the first exemplary embodiment of an apparatus 100 for manufacturing an electronic device. In particular a male electrical connector 102 according to the SATA industry standard for a storage device (such as a hard drive) is picked up and placed on a circuit board by a pick and place machine, and mechanically and electrically connected to the circuit board. Because the connector 102 does not have any surfaces suitable for the vacuum head of the pick and place machine, a cap 104 is temporarily attached to the connector 102 during the pick and place operation. After the pick and place operation the cap 104 is ejected from the connector 102.

The connector 102 will now be described with reference to Figures 1(a) to 1(d). The connector 102 is generally elongate, with a set of non deflecting metallic contacts 106 spaced along an upper face of one long edge. The contacts 106 are designed to electrically contact with corresponding contacts within a female SATA connector, when

mated. Each contact 106 is semi recessed into the connector 102, with adjacent contacts spaced by a plastic portion 132 to provide electrical insulation. A set of metallic pins are spaced on the opposite long edge, each electrically connected through the connector 102 to corresponding contacts 106. Each of the metallic pins are surface mounted to the circuit board using a reflow soldering process.

At an intermediate location, a U shaped slot 124 extends between the contacts 106. When the connector 102 is in use, the U shaped slot 124 is used to help mate to the female SATA connector. The U shaped slot 124 is bounded on one side by a first key 120 and on the other side by a second key 122. The keys 120,122 extend upwardly above the contacts 106. A locking detent 118 is provided on the underside near the opposite long edge, which in use helps to secure the female SATA connector when mated.

The connector 102 is generally constructed of moulded plastics, for example high temperature thermoplastic.

The cap 104 will now be described with reference to Figures 3(a) to 3(d). The cap 104 is integrally constructed of moulded plastics. The moulded plastic may generally be a high temperature thermoplastic. Because the cap 104 needs to stay secured during the reflow soldering, it needs to be able to withstand temperatures up to 260°C. Liquid crystal polymer, for example, may have a heat deflection temperature of over 600°C.

The cap 104 is generally "C" shaped in side view, with three main surfaces; a top surface 108, a back surface 109 and a bottom surface 110. Each of these three main surfaces may be substantially smooth and of appropriate dimensions to allow the vacuum head (which may be up to 5mm in diameter) to reliably attach to the surface. The top surface 108 and bottom surface 110 are substantially parallel to each other and the back surface

109 is substantially perpendicular to both. This means that cap 104 can be used for Vertical, Normal Right Angle, and Inversed Right Angle SMT connectors.

Underneath the top surface 108 is a first or top jaw 112. The top jaw 112 runs the length of the cap 104. Extending downwardly from the top jaw 112, are a series of teeth. According to the view in Figure 3(b), with a generally front view (with the back surface 109 facing away) the right hand end of the cap 104 is a first end 152. A first wider tooth 126 is adjacent to, but having a space 146 from the first end 152. A second end 154, opposite to the first, is at the left hand end of the cap 104. Second 128 and third 134 teeth are located intermediate between the first 152 and second 154 ends. A forth tooth 136 is located substantially at the second end 154. The second 128 and third 134 teeth are intermediate in width and the forth tooth 136 is narrower.

Extending from the second 128 third 134 and forth teeth 136 are a set of ribs 130. Each rib is much narrower and shorter than the corresponding tooth. The first tooth 126 does not have a rib. The top jaw 112 has bevelled front edge 140 at its front edge for ease of insertion to the connector 102, and a bevelled corner 144 at the first end 152.

Above the bottom surface 110 is a second or bottom jaw 114. The bottom jaw 114 runs a significant portion of the cap 104 starting from the first end 152. The top jaw 112 and the bottom jaw 114 are approximately the same depth. At the front tip end of the bottom jaw 114 on the upper face a protrusion 142 extends along the length and faces upward. A bevelled edge 150 also extends on the lower side or the front tip of the bottom jaw 114 where it joins the bottom surface 110. Between the second end 154 and the end of the bottom jaw 114, a locking finger 116 extends frontwardly from the back surface 109. At the front tip of the locking finger 116 on the upper face a locking protrusion 138 faces upward.

The cap 104 is engaged to the connector as shown in Figure 2. Generally the ribs 130 are positioned to mate against the plastic portions 132 between the contacts 106. In this way a firm interference fit between the ribs 130 of the top jaw 112 and the protrusion 142 of the bottom jaw 114, to the plastic portions of the connector 102, without contacting the metal contacts 106. This is especially important during the heating during the reflow soldering process, since the metal will expand at a different rate than the plastic. If a plastic pick and place cap formed an interference fit directly on the metal contacts 106, the engagement may be comprised during the reflow soldering process. To ensure that the cap 104 correctly locates in the connector 102, the width of the first tooth 126 is designed to mate with the U shaped slot 124. This alignment may assist with avoiding the ribs 130 contacting the metal contacts 106.

Most of the cap designs are using interference to provide the retention force of the cap. As stressed plastic material may release the stress under high temperature condition, the amount of interference for the cap must be controlled well in order to make sure that the cap will not drop during the reflow process. Such tolerance may be hard to achieve in practice, at a low cost.

To improve the reliability of the pick and place operation, an enhanced locking feature has been designed into the cap 104 to make sure that the cap 104 will not drop even the stress has been released during the reflow soldering process. The locking finger 116 uses the existing slot (the locking detent 118) which is provided on all type of SATA, SAS, MicroSATA, and MicroSAS connectors, to lock the cap 104 to the connector 102 so that during the reflow process the cap 104 will not drop. The locking protrusion 138 may be almost the same size as the locking detent 118 to maximise locking.

Figures 4 and 5 show the second exemplary embodiment of an apparatus 100 for manufacturing an electronic device. In particular a male electrical connector 402

according to the SAS industry standard for a storage device (such as a hard drive) is picked up and placed on a circuit board by a pick and place machine. In this case the connector 402 configuration is slightly different, in that a channel 424 is formed by first 420 and second 422 key. The channel 424 operates in much the same way, with the width of the first tooth 126 is designed to mate with the channel 424 to assist with alignment. Similarly the locking detent 418 locks with the locking protrusion 138 on the locking finger 116. In other respects the second exemplary embodiment is generally similar to the first exemplary embodiment.

Figures 6 and 7 show the third exemplary embodiment of an apparatus 100 for manufacturing an electronic device. In particular a male electrical connector 602 according to the microSATA industry standard for a storage device (such as a hard drive) is picked up and placed on a circuit board by a pick and place machine. Again, the connector 602 configuration is slightly different, in that a first key 620 is nearer the left end and a second key 622 is nearer the right end, when viewed from the front as in Figure 7. The left hand side of the first tooth 126 is designed to mate with the first key 620, and the right hand side of the forth tooth 136 is designed to mate with the second key 622 to assist with alignment. Similarly the locking detent 618 locks with the locking protrusion 138 on the locking finger 116. In other respects the third exemplary embodiment is generally similar to the first exemplary embodiment.

Figures 8 and 9 show the forth exemplary embodiment of an apparatus 100 for manufacturing an electronic device. In particular a male electrical connector 802 according to the microSAS industry standard for a storage device (such as a hard drive) is picked up and placed on a circuit board by a pick and place machine. The connector 802 configuration is slightly different, in that a first key 820 is nearer the left end and a second key 822 is nearer the right end, when viewed from the front as in Figure 9. The left hand side of the first tooth 126 is designed to mate with the first key 820, and the right hand

side of the forth tooth 136 is designed to mate with the second key 822 to assist with alignment. Similarly the locking detent 818 locks with the locking protrusion 138 on the locking finger 116. In other respects the forth exemplary embodiment is generally similar to the first exemplary embodiment.

Figure 10 shows a fifth exemplary embodiment of an apparatus 1000 for manufacturing an electronic device. In particular a male electrical connector 1002 according to the vertical SAS industry standard for a storage device (such as a hard drive) is picked up and placed on a circuit board by a pick and place machine. The vertical SAS connector 1002 is similar to the horizontal SAS connector 402 in the second embodiment. The main difference is that in use, the end surface 109 is used by the pick and place machine to pick up the connector 1002.

The cap 104 and connector 102 may be manufactured together with the cap 104 pre inserted. Alternatively the connector 102 may be manufactured separately and may only be manually combined just prior to the pick and place of the connector 102 onto the circuit.

A method 1100 for manufacturing an electronic device will now be described with reference to Figure 11. At 1102 an electrical connector for a data storage device is provided, for example according to the SATA industry standard. At 1104 a pick and place cap is placed onto the connector. The cap includes a set of jaws which are engaged over a row of connector contacts in the connector. During insertion and removal of the cap deformation of the contacts is substantially prevented. At 1106 the connector is picked up by a pick and place apparatus via the cap. At 1108 the connector is placed on a circuit board. At 1110 a reflow solder process mechanically bonds and electrically connects the connector to the circuit board. At 1112 the cap is removed from the connector.

Whilst there has been described in the foregoing description embodiments of the present invention, it will be understood by those skilled in the technology concerned that many variations in details of design, construction and/or operation may be made without departing from scope as claimed.

Reference Numerals

100 apparatus
102 SATA connector
104 cap
106 contacts
108 top pick up surface
109 back pick up surface
110 bottom pick up surface
112 first jaw
114 second jaw
116 locking finger
118 locking detent
120 first key
122 second key
124 U shaped slot formed by first and second key
126 first tooth
128 second tooth
130 rib
132 plastic between contacts
134 third tooth
136 forth tooth
138 locking protrusion

140 first jaw bevelled front edge

142 second jaw inner protrusion

144 first jaw bevelled corner

146 first jaw space

148 second jaw space

150 second jaw outer bevelled edge

152 first end

154 second end

400 apparatus

402 SAS connector

418 locking detent

420 first key

422 second key

424 channel formed by first and second key

600 apparatus

602 microSATA connector

618 locking detent

620 first key

622 second key

800 apparatus

802 microSAS connector

818 locking detent

820 first key

822 second key

1000 apparatus

1002 vertical SAS connector

1100 method

1102 connector provided

1104 cap placed

1106 the connector picked

1108 connector placed

1110 reflow solder process

1112 cap removed

Claims:

1. A pick and place cap comprising

a first jaw and a second jaw configured to extend over a row of connector contacts of an electrical connector when in an assembled configuration, the first jaw and the second jaw comprising at least one major external surface configured for attachment to a pick and place apparatus,

a plurality of ribs extending from the first jaw configured to engage portions of the electrical connector between the contacts and to be substantially spaced from the contacts when in the assembled configuration, and

at least one portion of the cap configured to engage between two key portions of the electrical connector to substantially locate the cap relative to the electrical connector when in the assembled configuration.

2. The cap in claim 1 wherein the at least one portion comprises a first tooth extending from the first jaw configured to engage between two closely spaced key portions of a first predetermined type of electrical connector when in the assembled configuration.

3. The cap in claim 2 wherein the cap is substantially elongate having a first end and a second opposed end, the at least one portion further comprises a second tooth, the first tooth substantially adjacent the first end and the second tooth substantially adjacent the second end, the first tooth configured to engage a first key portion of a second predetermined type of electrical connector and the second tooth configured to engage a second key portion of the second predetermined type of electrical connector when in the assembled configuration.

4. The cap in any one of the preceding claims wherein the first jaw and the second jaw substantial clamp onto the electrical connector to thereby secure the cap when in the assembled configuration.

5. The cap in claim 4 further comprising a locking finger substantially adjacent to the second jaw configured to engage a locking detent in the electrical connector to assist securing the cap when in the assembled configuration.

6. The cap in claim 5 wherein the locking finger is shorter than the second jaw, the locking finger having a protrusion substantially at an extremity thereof.

7. The cap in any one of the preceding claims wherein the first jaw and the second jaw further at least one further external surface, the first jaw and the second jaw configured for vertical or horizontal attachment to a pick and place apparatus.

8. The cap in any one of the preceding claims substantially composed of high temperature thermoplastic or liquid crystal polymer (LCP).

9. The cap in any one of the preceding claims further comprising a plurality of ribs, each rib extending from a corresponding tooth.

10. The cap in claim 9 wherein each rib is substantially thinner than the gap between each contact.

11. The cap in claim 9 or 10 wherein each tooth is spaced from the corresponding contact.

12. The cap in any one of the preceding claims wherein the electrical connector comprises a data storage connector.

13. The cap in claim 12 wherein the data storage connector is selected from the group consisting of a SATA connector, a SAS connector, a microSATA connector, a microSAS connector and a vertical SATA connector.

14. An apparatus comprising:

an electrical connector , and

a cap according to any one of claims 1 to 14, the cap configured for engagement with the connector.

15. A method comprising:

picking up an electrical connector via a pick and place cap, the cap engaged with the connector, with a first jaw and a second jaw engaged over a row of connector contacts and a set of ribs extending from the first jaw with portions of the connector engaged between respective contacts whilst substantially avoiding contact between the ribs and respective contacts, and

placing the connector on a circuit board.

16. The method of claims 15 further comprising locating the cap at a predetermined location.

17. The method in claim 16 wherein the predetermined location is relative to a slot or channel in the connector.

18. The method in claim 16 wherein the predetermined location is between corresponding keys in the connector.

19. The method of any one claims 15 to 18 further comprising placing the pick and place cap onto the connector prior to picking up the connector.

20. The method of claim 19 further comprising locking the cap in place on the connector.

21. The method of any one claims 15 to 20 further comprising removing the pick and place cap from the connector after placing the connector.

22. An electronic device manufactured according to the method of any one of claims 15 to 21.

23. A pick and place cap comprising:

a pick and place cap configured to mate with at least two different types of data storage connectors and comprising:

a first tooth for defining a location of the cap when the cap mates with the first type of data storage connector;

a different second tooth for defining a location of the cap when the cap mates with the second type of data storage connector; and

a plurality of insulative ribs, such that when the cap mates with each of the first and second types of data storage connectors, the plurality of the insulative ribs only engage areas between contacts of the data storage connector.