Abstract: The present invention relates to an adapter (101) for a motor comprising: (a) a base (106) having a motor-facing side and a board-facing side (201); (b) motor holding means (111) on the motor-facing side of the base (106); and (c) a plurality of electrical connectors (105) passing through the base between the motor-facing side and the board-facing side (201). The connectors (105) on the motor-facing side are tulip contacts and on the board-facing side (201) the connectors (105) are surface-mount contacts (203) protruding from the surface (202) of the base (106) of the board-facing side (201).
Adapter plate with surface mount contacts

TECHNICAL FIELD

The present invention relates to an adapter for connecting a motor or an actuator to a printed circuit board (PCB). More specifically, the adapter in accordance with the present invention can be used, in particular, to connect miniature stepper motors for automotive instrumentation applications to the cluster's PCB. The invention likewise relates to a method of connecting a motor to a PCB. The invention also relates to an assembly comprising the adapter, the motor, and the PCB.

BACKGROUND OF THE INVENTION

Traditionally, miniature stepper motors have been connected directly to a PCB. The electronic and mechanical connection can be obtained by, for instance, soldering the connectors of the motor to the PCB. Another connection method called press-fitting also exists, which does not require soldering and allows electrical and mechanical connection by mechanical deformation of a connector in a drill hole of the PCB.

Miniature stepper motors can be used for many purposes, such as automotive instrumentation applications. Stepper motors (or step motors) are brushless, synchronous electric motors that can divide a full rotation into a large number of steps. The motor's position can be controlled precisely without any feedback mechanism, as long as the motor is carefully sized to the application.

The PCB and stepper motor assembly is often subjected to potentially considerable vibrations and thus connecting the stepper motor directly to the PCB is not optimal. The cluster manufacturer positions all of the surface-mounted PCB components through automatic pick and place technology, and then the oven bonds these components to the PCB. An exception is usually made for the stepper motor as it is not a surface-mounted device (SMD), and has to be manually inserted and often manually soldered to
the PCB. This operation costs the manufacturer time and money, and inserts a manual process into the automatic assembly.

It is the aim of the present invention to provide a solution that overcomes the above-identified shortcomings.

SUMMARY OF THE INVENTION

According to a first aspect of the invention, an adapter for a motor is provided as recited in claim 1.

The proposed adapter has many advantages. The adapter according to the present invention is reusable. The adapter can be oven-bonded to the surface of the PCB, and it can be removed by heating the PCB containing the adapter. The adapter has also mechanical, easy-to-use holding means for the motor. The adapter can also have a spring for eliminating any play between the motor and the adapter.

Furthermore, the use of the adapter allows the cluster manufacturer to integrate the stepper motor into the automatic pick and place environment. Once positioned, the adapter can be SMD bonded together with the rest of the cluster components.

Once positioned and bonded, the adapter is ready for use. The motor can be clipped into the adapter at any time or phase of the assembly process. The motor can also be easily removed and replaced if necessary.

According to a second aspect of the invention, an assembly comprising the adapter according to the first aspect and further comprising a motor and a PCB is provided as recited in claim 10.

According to a third aspect of the invention, a method of attaching a motor to a printed circuit board is provided as recited in claim 12.
Other aspects of the invention are recited in the dependent claims attached hereto.

**BRIEF DESCRIPTION OF THE DRAWINGS**

Other features and advantages of the invention will become apparent from the following description of a non-limiting exemplary embodiment, with reference to the appended drawings, in which:

- Figure 1 is a perspective view showing the adapter from the motor-facing side in accordance with an embodiment of the present invention;

- Figure 2 is a perspective view showing the adapter from the board-facing side in accordance with an embodiment of the present invention;

- Figure 3 is a side view of the adapter of Figures 1 and 2; and

- Figure 4 is a perspective view showing an assembly comprising the adapter of Figures 1-3, a motor and a PCB.

**DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION**

One embodiment of the present invention will be described in the following in more detail with reference to the attached figures. This embodiment of the present invention is described in the context of an adapter for stepper motors, but the invention is not limited to the adapters for stepper motors.

Figure 1 shows in a perspective view an exemplary embodiment of the adapter 101 seen from the motor-facing side 103. Figure 2 shows the same adapter, but shown from the PCB facing side 201. The proposed adapter 101 offers an SMD method of connecting automotive stepper motors to a PCB by use of the proposed adapter 101. The method is based on the use of SMD contacts on the board-facing side 201, as will be explained later in more detail.
The material used for the adapter 101 can be for example TV4 260 S Polybutylene Terephthalate (PBT).

A plurality of electrical and mechanical connectors 105, in this example eight, traverse the base 106 of the adapter 101 laterally, i.e. from the motor-facing surface 107 to the board-facing surface 202. The motor-facing end of the connectors 105 is a female contact, called tulip contact 108. The motor then has male connection pins, which allow the motor to be electrically and mechanically connected by insertion in the tulip contact 108 without any trauma for the motor. The tulip contact 108 has a hollow interior for receiving the connection pins. The hollow interior comprises contact areas for making an electrical and mechanical contact. The main difference between a normal female contact and a tulip contact is that the normal contact has two contact areas, whereas the tulip contact has five contact areas. The five contact areas have a greater mechanical holding force and assure a better electrical contact force than the two contact solution. The tulip contact part of the connector 105 preferably does not extend from the motor-facing side 103 beyond the board-facing surface 202.

Figure 2 shows the adapter 101 from the bottom, i.e. from the board-facing side 201. From this figure the other end of the connectors 105 that pass through the adapter 101 via drill holes can be clearly seen. The board-facing end of the connectors 105 is a surface mount contact 203. This means that this end of the connectors 105 does not pass through the PCB. The surface mount contacts 203 can be bonded to the surface of the PCB.

The adapter 101 has also guide holes 109 for motor centring pegs. These holes help to guide the motor in place on the motor-facing surface 107 of the adapter 101. Furthermore, the holes guarantee that the motor cannot be reversely attached to the adapter 101. On the board-facing surface 202 there are provided guide pegs 205 for guiding the adapter 101 to the PCB. These guide pegs 205 preferably protrude from the board-facing surface 202 at least as much as the surface mount contacts 203. In this example the adapter 101 has two guide pegs 205, but of course the adapter can have any other number of guide pegs. These pegs 205 are used to guide the adapter to the PCB and
not to allow reverse attachment. These guide pegs 205 allow automatic pick and place positioning when assembling different components to the PCB. The guide pegs 205 have ribs 207 that are in this example made of plastic and can deform when putting the adapter onto the PCB. Thus, the adapter 101 can be held firmly with respect to the PCB during the positioning phase of the adapter 101.

The adapter has also a play eliminating means 113, which is in this example a spring. The purpose of this spring 113 is to eliminate any play between the motor and the adapter motor-facing surface 107. The essentially flat bottom surface of the motor is arranged to come into contact with this spring 113. Thus, the spring is arranged to move vertically with respect to the plane defined by the motor-facing surface 107. On the adapter 101 there are further provided means 111 for holding the motor. These holding means are in this example clips 111. The motor is arranged to go slightly deeper than the clips 111 in order for the clips 111 to close properly. The horizontal plane is assured to be free of play due to the clips 111, the connectors 105 and the guide holes 109 together with the motor centring pegs. The vertical plane is held under control by the spring 113 as the clips 111, the motor centring pegs and the connectors 105 move vertically. The large through hole in the middle of the adapter 101 is where the shaft of the motor is arranged to come out if the shaft is located on the bottom surface of the motor.

When putting the adapter onto the PCB, the adapter 101 can be bonded to the PCB together with all of the other cluster components. The use of the adapter 101 allows the cluster manufacturer to integrate the stepper motor into the automatic pick and place environment. Once positioned, the adapter 101 can be SMD bonded together with the rest of the cluster components. The adapter 101 is bonded to the PCB through a solder reflow process. This kind of bonding covers oven bonding, gas, electric infrared (IR), etc. The adapter 101 in accordance with the present invention can be fitted together with all of the other cluster components, and then run through an oven for bonding. Therefore, the adapter 101 in accordance with the present invention withstands pressures and/or temperatures which the motor cannot. This means that the customer can fit the motor to the PCB, and manual
operation is not required. Many cluster manufacturers mount the cluster components in one location, and then assemble the cluster in another. By doing so, the motor shaft is exposed in traditional methods to possible damage, and requires special packaging. However, with the adapter solution in accordance with the present invention, the motor can be simply popped into place during the final assembly.

In the most common implementations, the adapter 101 is available in a 4 or 8 contact version, front or rear contacts (referring to the motor contacts). The adapter 101 of the present invention is suitable to be used with motors with front or rear contacts. Once positioned and bonded, the adapter 101 is ready for use. The motor can be clipped into the adapter 101 at any time or phase of the assembly process. The motor can also be removed and replaced if necessary. Figure 4 shows the assembly before being assembled. The assembly comprises the motor 401, the adapter 101 and the PCB 403.

While the invention has been illustrated and described in detail in the drawings and foregoing description, such illustration and description are to be considered illustrative or exemplary and not restrictive, the invention being not limited to the disclosed embodiment. Other embodiments and variants are understood, and can be achieved by those skilled in the art when carrying out the claimed invention, based on a study of the drawings, the disclosure and the appended claims.

In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality. The mere fact that different features are recited in mutually different dependent claims does not indicate that a combination of these features cannot be advantageously used. Any reference signs in the claims should not be construed as limiting the scope of the invention.
Claims

1. An adapter (101) for a motor (401) comprising:

   • a base (106) having a motor-facing side (103) and a board-facing side (201);

   • motor holding means (111) on the motor-facing side (103) of the base (106); and

   • a plurality of electrical connectors (105) passing through the base (106) between the motor-facing side (103) and the board-facing side (201), wherein

      the connectors (105) on the motor-facing side (103) are tulip contacts (108), and on the board-facing side (201) the connectors (105) are surface-mount contacts (203) protruding from the surface (202) of the base (106) of the board-facing side (201).

2. An adapter according to claim 1, wherein the base (106) further comprises a spring (113).

3. An adapter according to claim 2, wherein the spring (113) is arranged to move vertically with respect to the plane defined by the surface (107) of the base (106) of the motor-facing side (103).

4. An adapter according to any of the preceding claims, wherein the surface (107) of the base (106) of the motor-facing side (103) contains at least one motor guiding hole (109).

5. An adapter according to any of the preceding claims, wherein the motor holding means are clips (111).
6. An adapter according to any one of the preceding claims, wherein the surface (202) of the base (106) of the board-facing side (201) comprises at least one adapter guide peg (205).

7. An adapter according to claim 6, wherein the adapter guide pegs (205) comprises elastically deformable ribs (207).

8. An adapter according to claim 6 or 7, wherein the guide pegs (205) extend further away from the base (106) than the surface mount contacts (203).

9. An adapter according to any one of the preceding claims, wherein the tulip contacts (108) have a hollow interior part, and the hollow part does not extend beyond the surface (202) of the base (106) on the board-facing side (201).

10. An assembly comprising the adapter (101) according to any one of the preceding claims, and further comprising a motor (401) arranged to be attached to the motor-facing side (103) of the adapter (101) and being arranged to be mechanically and electrically connected with the adapter (101), and further comprising a printed circuit board (403) for receiving the adapter (101), and wherein the adapter (101) is mechanically and electrically connected to the printed circuit board (403).

11. An assembly according to claim 10, wherein the adapter (101) is surface-mounted to the printed circuit board (403) by bonding.

12. A method of attaching a motor (401) to a printed circuit board (403), the method comprising surface mounting the adapter (101) according to any one of the claims 1 to 9 to the printed circuit board (403) and putting the motor onto the surface (107) of the base (106) on the motor-facing side (103) by use of the motor holding means.

13. A method according to claim 12, wherein the adapter is bonded to the printed circuit board (403) through a solder reflow process.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
INV. H02K5/22 H02K11/00 H02K37/00

ADD.
According to International Patent Classification (IPC) and (to both national classification and IPC)

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H02K H01H B25F H05K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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[ ] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

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Date of the actual completion of the international search: 30 January 2012
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