Evolving Connector for Mobile electronic device

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Recent years have seen a worldwide explosive growth of various mobile electronic devices such as a smart phone, a tablet terminal and an AV equipment. Achieving key features not only expanded functionality but slim and smart design are essential to these mobile electronic devices. To that end it is indispensable for the electronic components used in those devices to be compact and lightweight as well as to have high functionality.

DDK Ltd. manufactures and sells connectors for such devices for many years. These days especially it has become more and more important for us to research and develop connectors by being in advance of the electronic device technology which progresses quickly and continually.

In this paper we will explain the features of our typical connectors using the examples and introduce part of the technology which we have so far created.

1. Introduction

DDK Ltd. ¹ is a general connector maker which is a company of the Fujikura group. The connector has to connect a signal and an electric power by low losses between circuits, terminals and cables. Therefore, the conductor and the insulation material with good electrical characteristics and a mechanism for secure mating is required to the connector. Also it requires a good environmental characteristics.

Our product is a connector used for a mobile electronic device, IT, car-electronics and factory automation. Recently miniaturization and weight reduction of the mobile electronic device are in progress. Therefore, the connector has required a low profile and narrow pitch of contact. In high-speed data communication, standard for high-speed transmission of from 8 to 10 Gbps has entered the final stages for the enactment. Such as high-speed interface of SATA has become an urgent issue. On the other hand, as a connector to be used for internal wiring for a mobile phone, a smart phone, a note PC, a tablet device and a portable music terminal have been developed new products such as connector for connection between the PCB and the FF series for FPC, as the best product, these connectors are used by many customers for slim and compact electronic devices.

2. Technical issues of a connector for a mobile electronic device

The FPC is used for many internal wiring in the mobile electronic device that is portable on a daily basis. Our FF series as shown in Figure 1 is very thin and flat type that has to great effect for miniaturization and lightweight of electronic devices. The height of a connector from implemented PCB is 0.66 mm. Also a pitch between contacts is 0.3 mm. Features of this FF connector are narrow pitch and ultra-low profile.

When using miniaturization coaxial cable, you can use a coaxial connector as shown in Figure 2. A recept
tacle is mounted on the PCB, and a plug is a connected to the cable. When both are mating, the height of a connector is 1.5 mm. We have achieved phenomenal low profile, while exhibiting the features and functions of the coaxial connector.

When combined with the two facing PCB, the connector between the substrates as shown in Figure 3 are used. There are two types at the board to board connector. These are the coaxial type and the rectangular multi-pin type. May be selectively used depending on the form of the transmission signal has a large effect on the thinning of the device.

These connectors had some major problems until now. In the FF connector, there is a problem at a soldering work. FF series connectors are small and very thin, so solder bridge is likely to occur. Further, the board to board connector, there is a problem of positional deviation of the receptacle and plug when implemented. Require advanced manufacturing technology, to increase the accuracy of the mounting position is also a cost factor.

A lateral dimension of many contact’s FF connector is greater than the dimension of a depth direction and a vertical direction. This is a large aspect ratio flat shape. Contacts of connector are fixed by a plastic housing, if there is a large difference in the ratio of three sides at this plastic housing, the problem of warp or deformation easily occurs.

Also, FF connectors are very small parts. When soldering work, there was a rising flux problem could occur due to a small gap of housing and a contact by capillary action. When a flux penetrate inside a connector, the flux would cover a surface of contact, so it will cause blocking of the signal. Moreover, the FF connector is very compact. When inserting the FPC in a connector, workability is concerned.

In the board to board connector, it is important to match the location of the connectors that are implemented on separate substrates. Requires precision and accurate implementation of the connector of the circuit pattern design in order to match the location of the connectors on separate substrates. If two or more board to board connectors are used for the PCB is a particularly serious problem. For solving these problems, we describe in the next section as an example of the case of the PMU and the FF series connector.

### 3. New technology of the connector for mobile electronic devices

In the FF series connectors there are many types, you can choose the most suitable connector by FPC type and PBC type. We describe the new technology by FF20 connector. Table 1 shown compared to the specifications of a conventional connector FF12 and new FF20. The FF20 connector can be seen that the smaller volume in the ultra-low profile, it is very space-saving connector for the FPC.

At the ejection molding, warping or deformation occurs is easy as shown in Figure 4 because the FF connector is very thin. So the flow of the resin has a great influence for occurrence of deformation. We simulate by a flow analysis in order to resolve this problem. In the simulation, we aim to optimize the location of gate or the temperature of resin. Figure 5 is shown the result of simulation. We are performed a structural anal-

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<table>
<thead>
<tr>
<th>Item</th>
<th>FF20</th>
<th>FF12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height</td>
<td>0.66 mm</td>
<td>0.90 mm</td>
</tr>
<tr>
<td>Depth</td>
<td>3.80 mm</td>
<td>4.93 mm</td>
</tr>
<tr>
<td>Width (24pin)</td>
<td>8.60 mm</td>
<td>9.40 mm</td>
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<tr>
<td>Volume ratio</td>
<td>0.52</td>
<td>1</td>
</tr>
<tr>
<td>Contact pitch</td>
<td>0.30 mm</td>
<td>0.30 mm</td>
</tr>
</tbody>
</table>

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**Table 1. Specifications of FF connector.**
ysis using a model of the product prepared in the mold was then obtained by flow analysis. We have established the mold structure and ejection molding conditions optimal in this way. For more information, please refer to the technical information of the WEB 2).

With respect to the rising flux during the mounting, we simulate by structural analysis to ensure a capillary action does not cause. Also the gold plated has so well wet ability. So removing some portion of the gold plating of contacts by Laser. We are prevented from entering the flux into the connector from the substrate by these methods.

The FF connector for the FPC has mechanism to lock the FPC. The lock lever of the FF connector is placing on the opposite side at the FPC insert side, it is easy to insert the FPC. Furthermore, if the FPC moves up and down, the lock is not released. The structure is shown in Figure 6.

This structure is referred to as back-lock, in a very unique structure which was developed by DDK ltd., this is a high reliable locking mechanism. In the structure of back lock, the lock lever is tilting to the reverse side to insert the FPC. This method has the advantage that the FPC does not shift easily, when locked. Already, with respect to this structure we had patented 3).

Also FF series connectors have used a cable lock system which was developed by DDK ltd.. FF23, FF28 and FF18 connectors are equipped with a cable lock. These are connectors for 0.12-mm-thick FPC. A height of FF18 is 0.66 mm and a contact pitch is 0.4 mm. A height of FF23 is the same as that of FF18, and a contact pitch is 0.3 mm. FF28 is the type which made a contact pitch still narrower with 0.25 mm. A cable lock is the structure where a lock contact of FF connector fixed the notch of FPC. A lock contact is arranged at both the outermost side of a contact for signals of FF connector, and the notch is prepared in the end of FPC. As shown in Figure 7, if a lock lever is tilted, a tip of cable lock contact is closed together with a signal contact. So the notch of FPC is fixed. These type connectors are effective for fixing FPC of low number of contacts. This method has been patented in our original lock system 4).

The following is describing the new technology of the board to board connector.

A board to board connector is a connector that can be fitted with two opposed PCBs. Horizontally arranged PCBs can be arranged up and down, the mounting area in an electronic device can be made into a half. The height of mating the board to board connector between two PCBs is the gap between two PCBs. The distance between PCBs becomes the height of mated connectors. DDK’s board to board connector is very low profile that has great effect to the reduction in thickness of electronic devices. However, a positional shift of the implementation of a connector was a big

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**Fig. 4. Deformation of FF connector.**

**Fig. 5. Ejection molding simulation result.**

**Fig. 6. DDK’s original rotate oval cam lock mechanism.**

**Fig. 7. DDK’s original cable lock mechanism.**
problem. When location of connectors on two PCBs are shifted, that two PCBs can not be mated. We developed a floating structure as a way to solve this problem. The floating structure of the coaxial connector is as on the left side of Figure 3. As shown in Figure 3, the PMU connector consists of three pieces. So this structure can cope with the positional deviation in the direction X, Y and Z due. An intermediate adapter can absorb the positional deviation of the connector on the PCB. The positional deviation that can be adjusted with this structure is a up to 0.8 mm in Z direction and ±0.5 mm in X or Y direction. Next is about the electric characteristic of the PMU connector. Figure 9 shows the result of VSWR in the case where the PMU connector is mating PCBs at the positional deviation. In the maximum positional deviation, VSWR is less than 1.2 at 6GHz. Since the standard is less than 1.3 at 6GHz, which is a good result. This technology is already introduce by Fujikura News9).

4. Conclusion

We took up the example of FF and PMU connector for the mobile electronic device, and explained a recent connector’s technical problem and how to resolve them. We will continue doing research and development of new products that meet the demand of the market. And we will produce reliable products for the customers, and contribute to the society.

Reference

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