Research on the application of single point conductive adhesive in the electrical interconnection of display screen

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Abstract: This paper studies the application of the single point conductive adhesive in the electrical interconnection of the display screen. The two ends of the electrical interconnection of the single point conductive adhesive are welding form and contact form respectively, and the volume is very small. The single point conductive adhesive can be soldered on the circuit board together with the circuit components, and the display screen can also be solderless flexible interconnection. However, because there is no suitable packaging form of display screen in the market at present, the display screen is modified in this study, and the display screen and circuit board are interconnected with single point conductive adhesive. The working effect of display screen and the power change of circuit board after interconnection with single point conductive adhesive are tested. The experimental results show that the display screen interconnected with single point conductive adhesive can work normally, the voltage of the interconnection point has a slight increase, and the input power of the circuit board has a slight increase. The experimental results show that the single point conductive adhesive can be used in the interconnection of display screen.

1. Introduction
For the display screen, whether it is organic light-emitting diode (OLED) or liquid crystal display (LCD), there are two ways of electrical interconnection between the screen glass and the circuit board, one is the use of conductive tape, the other is the use of flexible printed circuit (FPC). Conductive adhesive tape is the first choice for the electrical interconnection of some low-cost displays, which is basically used for LCD screens. However, in order to make good contact between the display screen and the circuit board, this method requires a heavy connection holder. This leads to a large volume of display connected with conductive tape, which is not conducive to circuit miniaturization. At the same time, the heavy connection holder is not conducive to the production and assembly under automation, resulting in low production efficiency. Using FPC to interconnect the screen glass and circuit board is the mainstream way, which is widely used in OLED and LCD. The use of FPC interconnection makes the size of the display smaller, which is conducive to the integration of circuit miniaturization, and the fixed way of the display becomes flexible, the production and assembly process also has a certain degree of automation, and the production efficiency is higher. However, this interconnection method needs additional parts to manufacture FPC, which increases the steps in production and increases the
additional manufacturing cost. At the same time, because FPC is used as an interconnection bridge in this way, it can not reach the level of fully automated production. The purpose of this paper is to explore a new electrical interconnection method to reduce the interconnection volume of screen glass and circuit board, reduce the steps in the production of display and improve the degree of automation. The single point conductive adhesive is different from the conductive adhesive strip and FPC. The two ends of the electrical interconnection of single point conductive adhesive are welding form and flexible contact form respectively. A simple connection holder is needed for interconnection using single point conductive adhesive, but the volume of interconnection is much smaller than that using conductive adhesive. Because the single point conductive adhesive can be welded on the circuit board together with the components, this method saves one production step compared with FPC interconnection. Because the single point conductive adhesive adopts a simple vertical interconnection method, it also creates a good condition for completely automatic production.

2. Materials and Methods

The content of this study is to use the single point conductive adhesive as the interconnection material between the display screen and the circuit board, detect whether the display screen and the display system work normally, measure the power consumption of the display system in a certain working time interval, and compare the single point conductive adhesive with FPC to judge whether the power consumption is reasonable. Because there is no display packaging form suitable for single point conductive adhesive in the market at present, a liquid crystal display system interconnected with FPC was refitted in the research experiment. A part of the interconnection in the system is separated. The interconnection mode of this part is to use a adapter plate to connect with the single point conductive adhesive, which is used as the electrical connection between the display screen and the single point conductive adhesive.

The experiment is divided into four steps. The first step is to weld the single point conductive adhesive with other circuit components to the circuit board, and reserve the position of the display screen. The welding situation of the single point conductive adhesive on the circuit board is shown in Figure 1. The test resistance of the single point conductive adhesive used in this experiment is 0.2 $\Omega$, and the bottom diameter is 2mm. It is produced by Guangdong Heyuandengke company. and provided by Guilin Hengchang Electronic Technology company.

![Figure 1. Effect of single point conductive adhesive welding on circuit board](image)

The second step of the experiment is to paste and fix the modified display screen on the circuit board, that is, fix the adapter board and the circuit board, and then measure whether the interconnection points are connected together. Because the purpose of this experiment is only to verify whether the single point conductive adhesive interconnection can make the display screen work normally, the method of fixing the display screen in the experiment is to use the thin diameter bolts and nuts. The hardware of the display system is shown in Figure 2.

![Figure 2. The physical diagram of the display system](image)
The third step of the experiment is to turn on the circuit power and debug the system program. In this experiment, SMT32f103vbt6 chip is used to control the image acquisition and display, and Keil U vision 5 is used as the programming and burning software. The real-time image collected by the camera is displayed on the display screen to observe whether the image is in good condition. Detect whether the voltage value on the potential point connected between the circuit board and the display screen is in the normal range, measure the voltage value of the connected point in turn with an electric meter, and present the deviation between the voltage value and the normal value in the form of a table. The physical picture of the normal operation of the display screen is shown in Figure 3.

![Figure 3. Physical picture of normal operation of display screen](image)

The fourth step of the experiment is to measure the power of the display system with single point conductive adhesive interconnection in a certain working time interval. The power of the system with FPC interconnection is taken as a reference, and the power difference between the two is compared. Because the circuit boards and components of the two are the same, the only difference lies in the interconnection mode between the display screen and the circuit board, so measuring the input power of the display system can characterize the power difference of the display screen under the two interconnection modes. In this experiment, the input voltage and current are measured with an electric meter.

### 3. Results & Discussion

The experimental results show that the display screen interconnected by single point conductive adhesive can normally display the images collected by the camera, and the voltage value at the interconnection point between the display screen and the circuit board can be detected by electricity meter in turn. The test results of FPC interconnection and single point conductive adhesive interconnection are listed in Table 1. A total of three groups of data are detected and recorded.

| Connection point serial number | Voltage value of each connection point under two interconnection modes | The voltage value of connection point with single point conductive adhesive interconnection (v) | Voltage value of connection point in FPC interconnection mode (v) |
|-------------------------------|---------------------------------------------------------------|-------------------------------------------------|-------------------------------------------------|
|                               | The first group | The second group | The third group | The first group | The second group | The third group |
| 1                             | 0.98            | 1.21            | 0               | 0.96            | 1.18            | 0               |
| 2                             | 0.87            | 0.59            | 0.82            | 0.88            | 0.59            | 0.79            |
| 3                             | 0.59            | 3.25            | 0               | 0.58            | 3.25            | 0               |
| 4                             | 3.31            | 1.17            | 3.31            | 3.31            | 1.19            | 3.31            |
| 5                             | 1.20            | 0.71            | 3.31            | 1.18            | 0.70            | 3.31            |
| 6                             | 1.29            | 0.59            | 1.26            | 1.27            | 0.58            | 1.23            |
| 7                             | 0              | 0.59            | 1.16            | 0              | 0.57            | 1.14            |
| 8                             | 3.25            | 0              | 2.68            | 3.25            | 0              | 2.65            |

In order to compare the voltage difference between the two interconnection methods in each group of data, the voltage values of the two interconnection methods in each group of data at the same connection point are subtracted, and the subtraction difference among the three groups of data is
drawn into three broken lines. Put three broken lines into the same coordinate system diagram, as shown in Figure 4, showing the voltage difference changes of the connection points of the two interconnection modes.

![Figure 4](image)

**Figure 4.** The broken line diagram of voltage difference change at connection point

According to the results shown in Figure 4, it can be seen that under the two different interconnection modes, the voltage variation of each connection point is very small, and the maximum difference is only 0.03v, which can be regarded as basically consistent. Moreover, the voltage of the connection point using FPC interconnection is slightly lower than that using single point conductive adhesive interconnection.

The input voltage and current of the two interconnection modes are measured by ammeter every half an hour for 10 times. The display system of the two interconnection modes works synchronously for 4.5 hours. Put the measured data into table 2, and list the power corresponding to the data in Table 2.

**Table 2.** voltage, current and power values of system input under two interconnection modes

| time (h) | voltage (v) | electric current (mA) | power (mW) | voltage (v) | electric current (mA) | power (mW) |
|----------|-------------|-----------------------|------------|-------------|-----------------------|------------|
| 0        | 5.14        | 1.23                  | 6.3222     | 5.14        | 1.16                  | 5.9624     |
| 0.5      | 5.14        | 1.24                  | 6.3736     | 5.14        | 1.16                  | 5.9624     |
| 1        | 5.14        | 1.26                  | 6.4764     | 5.14        | 1.17                  | 6.0138     |
| 1.5      | 5.14        | 1.24                  | 6.3736     | 5.14        | 1.16                  | 5.9624     |
| 2        | 5.14        | 1.26                  | 6.4764     | 5.14        | 1.16                  | 5.9624     |
| 2.5      | 5.14        | 1.27                  | 6.5278     | 5.14        | 1.18                  | 6.0652     |
| 3        | 5.14        | 1.29                  | 6.6306     | 5.14        | 1.20                  | 6.168      |
| 3.5      | 5.14        | 1.26                  | 6.4764     | 5.14        | 1.17                  | 6.0138     |
| 4        | 5.14        | 1.24                  | 6.3736     | 5.14        | 1.16                  | 5.9624     |
| 4.5      | 5.14        | 1.26                  | 6.4764     | 5.14        | 1.18                  | 6.0652     |

According to table 2, it can be seen that the input voltage is constant, the stable voltage source is used in the experiment, and the input current changes in a certain range. The input current of single point conductive adhesive is slightly higher than that of FPC. This is related to what is shown in Figure 4, that is, the voltage of the connection point using FPC interconnection is mostly slightly lower than that using single point conductive adhesive interconnection.
For the convenience of observation, the data in Table 2 are interconnected to draw two time power broken lines and put in the same coordinate system. The line graph is shown in Figure 5.

![Image of line graph showing input power and working time under two interconnection modes.](image)

**Figure 5.** Working time and power diagram of input terminal under two interconnection modes

According to the content of Figure 5, we can know that the input power of single point conductive adhesive interconnection system is slightly higher than that of FPC interconnection system, but the change trend of the two is very similar, which indicates that the control of variables in this experiment is better, and the interference of other factors to the experiment is excluded. Because a single point conductive adhesive is added to the circuit, the circuit resistance is correspondingly increased, which will have an impact on the circuit current and power. However, because the resistance is relatively small, these effects are small. These weak effects are shown in Fig. 4 and Fig. 5 respectively.

4. Conclusions
According to the experimental results, compared with FPC interconnection, the display system using single point conductive adhesive interconnection can work normally. Although there are some changes of current and voltage in the circuit, it has little influence on the display screen. Because there is no suitable packaging form of display screen, the analysis of fixed structure is not given in the experiment.

In the future, if there is a display packaging form suitable for single point conductive adhesive, this research can be used as a reference for the new interconnection research of display, and ultimately achieve the purpose of reducing the interconnection volume, reducing the production steps and improving the degree of automation. Single point conductive adhesive can be used in the interconnection of display screen.

**Acknowledgments**
This paper is funded by Department of Guangxi Science and TechnologyGuangdong, Foshan, Nanhai, QDH Lake Talent Plan.

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