The Effects of Rubber Keys' Structure and Its Packaging Tape on Automatic Assembly of Rubber Key in PCB Holes

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https://doi.org/10.5109/5909078

出版情報：Proceedings of International Exchange and Innovation Conference on Engineering & Sciences (IEICES). 8, pp.128-133, 2022-10-20. Interdisciplinary Graduate School of Engineering Sciences, Kyushu University
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The Effects of Rubber Keys' Structure and Its Packaging Tape on Automatic Assembly of Rubber Key in PCB Holes

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Abstract: *The structure and material properties of the silicone rubber keys have great effects on the assembly reliability of the pins of the rubber keys' in the holes of the printed circuit board (PCB). Too soft pins cause the insertion problem but too stiff pins cause shock. The interference between insert pins and the holes in PCB also has effects on the insertion. The spreading of surface mount technology (SMT) has generated a need for flexible placement machines that are capable of placing components very fast in a large variety of component types. PCB components that are not placed correctly in the layout cause problems when the board is being assembled by the author. Incorrectly placed components do not solder correctly, which results in a host of reliability problems in this project. The author has made a tape design for packing the rubber key. Tape shape and keys base shape relation have effects on the assembly process.*

Keywords: SolidWorks software; SMT placement machine; Nozzle; Rubber keys; PCB

1. INTRODUCTION

A new silicon rubber key design has made for a flexible and quick automatic assembly process and better conductivity. At first, the dimensions of a sample key are assumed, and written the initial data. Then the final data was measured and made into a 2D drawing. After that, the initial product dimension was measured. Take the initial data and assume the key data from the initial data. Finally, determined the final data. Then it was easy to determine the rubber keys' dimensions. Finally, the design of the rubber key was made according to the final dimensions. Rubber keys assembly simulation- Solid work 2D and 3D has shown that the selected dimension of rubber key and nozzle design works faster than previous products.

Differential pressure devices such as orifice plates and nozzles are extensively applied in several industries in order to estimate the mass flow rate running through a conduit by correlating the measured pressure loss and the mass flow rate [1]. For measuring the fluid flow in a pipe, an entry nozzle is employed. For studying the essence of movement, an aerodynamic open tunnel is employed. The pressure drop in the pipe is measured to calculate frictional head loss [2]. Throughout history, nature has been the most obvious organizer of human life [3].

2. MATERIALS AND METHODS

At first, the dimensions of the sample keys were taken. Height, length, width, and distance between two keys of the sample key were measured. Fig. 1(a) shows the front view, fig. 1(b) shows the bottom view and fig. 1(c) shows the top view of the sample key below.

2.1 Write the initial data

After measuring the sample key, the initial data chart was made and shown below.

2.2 Assume the key data from the initial data

After the final key data was assumed from the initial data. PCB hole's diameter, the distance between two keys, height, and width was considered to assume the key data.

2.3 Final products dimension measurements

After considering all factors, the final data for the silicon rubber key was determined. The data table is below.

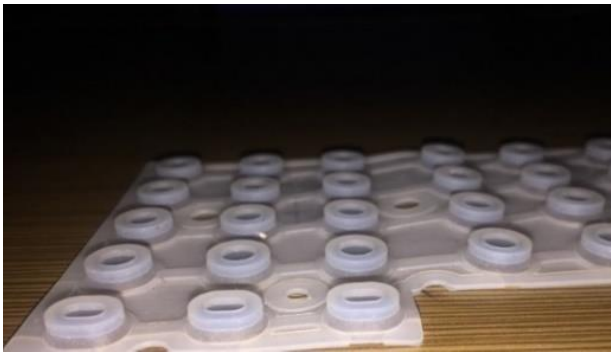


Fig. 1. (a) Front view of the sample key.

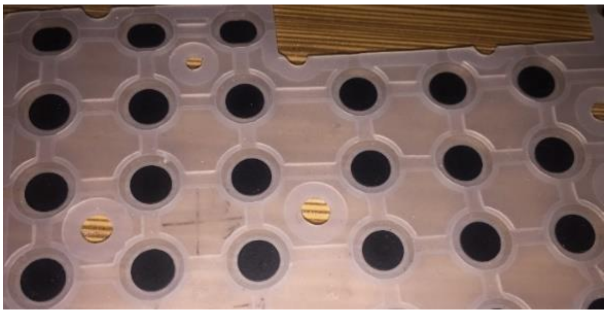


Fig. 1. (b) Bottom view of the sample key.

Fig. 1. (c)Top view of the sample key.

Table 1. Initial data table

Specification	*B1*
Button length L±0.1	16
Button width B±0.1	7
Base height H1± 0.1	1
High button H±0.1	9.5
Key surface diameter D±0.1	11
Conductor diameter d±0.1	6.5
Page center distance A±0.1	12
Pin diameter øh±0.1	2
Pin cone end diameter Øh1±0.1	1.2
Pin height H±0.1	4
Heart H1±0.1	2.5
Pin deformation hole depth øh2±0.1	1.2
Pin deformation hole depth h2±0.05	3.5

Table 2. Final data table

Specification	*B1*
Button length L±0.1	16
Button width B±0.1	10
Base height H1± 0.1	1
High button H±0.1	4
Key surface diameter D±0.1	10
Conductor diameter d±0.1	6
Page center distance A±0.1	9
Pin diameter øh±0.1	2
Pin cone end diameter Øh1±0.1	0.85
Pin height H±0.1	4
Heart H1±0.1	2.5
Pin deformation hole depth øh2±0.1	1.2
Pin deformation hole depth h2±0.05	3

2.4 Rubber keys assembly simulation (SolidWorks 2D)

The final dimension of the rubber key has been determined. According to the final dimension measurements, the SolidWorks 2D design of the rubber key was complete, as shown in fig. 2. The SolidWorks 2D design is below.

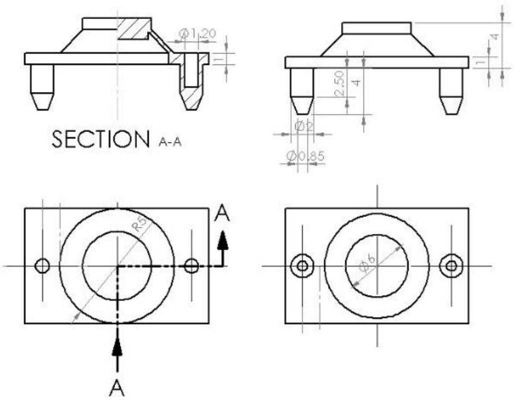


Fig. 2. SolidWorks 2D design based on final dimension.

2.4 SolidWorks 3D (Structure design, modeling, and assembly)

According to the final data fig. 3(a), fig3(b), fig 3(c), and fig 3(d) show the 3D design of the rubber key and PCB assembly.

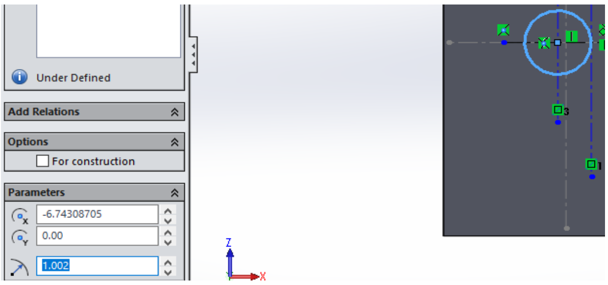


Fig. 3. (a) PCB holes diameter measurement.

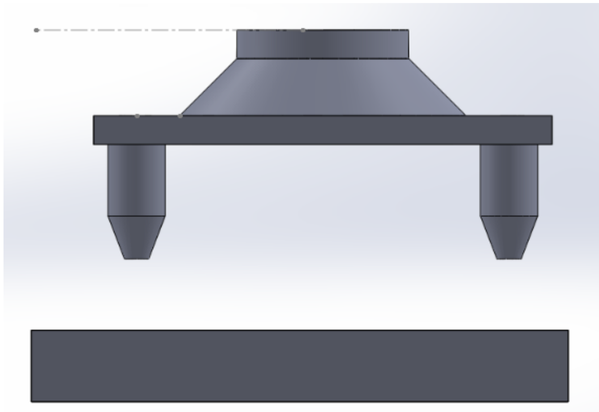


Fig. 3. (b) - SolidWorks 3D model of silicon rubber key and PCB (front view).

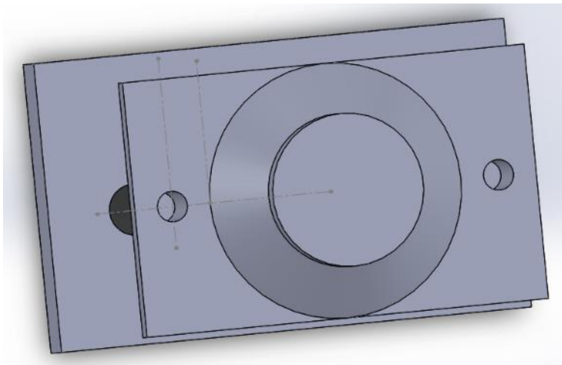


Fig. 3. (c) - Assembly of rubber key in PCB holes (Top view).

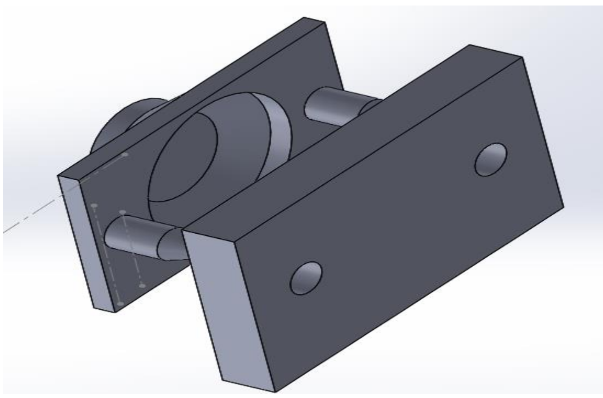


Fig. 3 (d) - Assembly of rubber key in
Rubber key in PCB holes (Bottom view).

2.5 Design of rubber keys according to the final dimensions

Fig. 4. front view.

2.6 Nozzle design (prediction and determination of the nozzle data)

The rubber key dimensions are already determined. That's why it must need to be considered the rubber key dimensions to predict the nozzle dimensions. Otherwise, it can't pick and place the rubber key properly during the automatic assembly process. Here the nozzle design has shown in fig. 5. It is usually placed in a pipe in which fluid flows [4].

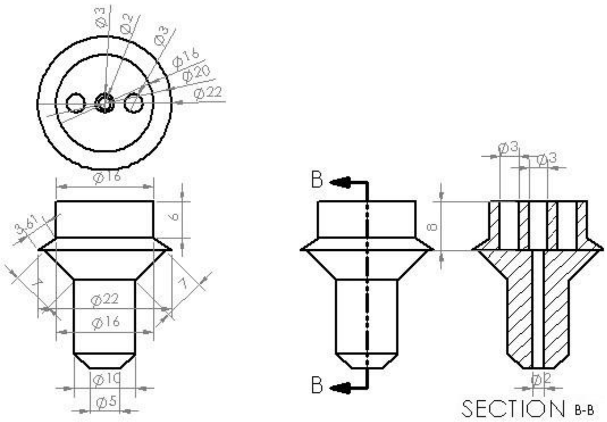


Fig. 5. B-B Section cut view and dimension determination design of the nozzle.

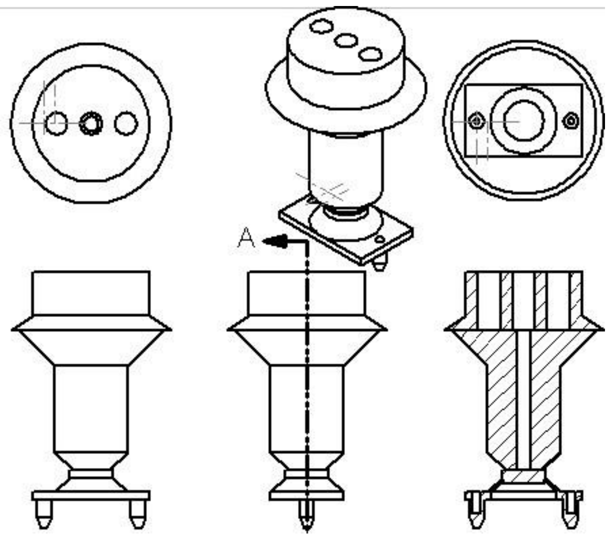


Fig. 6. Assembly of the nozzle and the rubber key 2D.

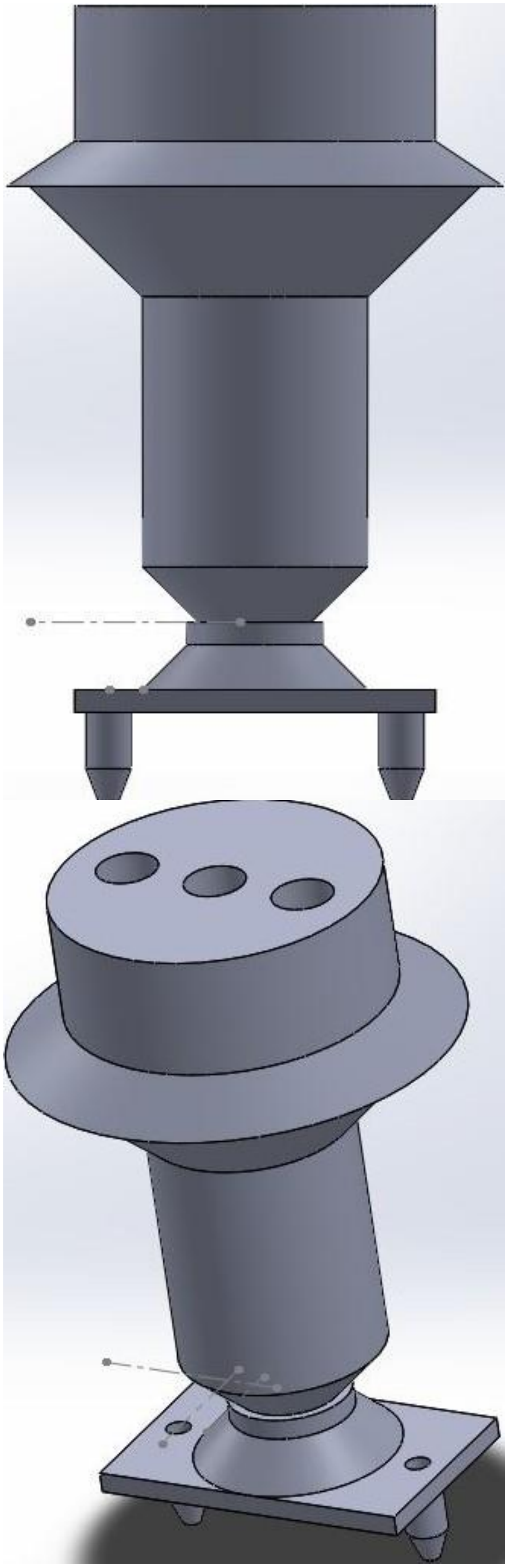


Fig. 7. Assembly of the nozzle and the rubber key 2D.

Here shown the B-B section cut. So that inside of the nozzle is clear to see. The dimension was taken as shown for designing the nozzle. The flexible dimension is determined that is perfect for our thesis and rubber key so that this nozzle can show better-suctioning performance during the automatic assembly process.

2.7 Assembly of the nozzle and the rubber key using SolidWorks 2D

Here the 2D assembly simulation of the nozzle and rubber key has shown in fig. 6. Here better effect is the main purpose and the result shows it has achieved the purpose, as the nozzle is suctioning the rubber key smoothly. The section view A-A helps to understand the design clearly. A nozzle plate, being a key part of steam engines, changes the flow directions of steam in a turbine used in a power plant [5].

2.8 Make SolidWorks 3D design simulation

simulation of the model using predicted parameters and validate the main parameters by simulation and experiments below in fig. 7.

3. RESULTS

Here the result is showing the design of the pick and place process by using SolidWorks. The process is very simple. The nozzle has better suction ability as it is a very important part of this research work and for the automatic assembly process. The nozzle has the suction capability. At first, the nozzle head starts suctioning to hold the bottom part of the nozzle. The bottom part holds the key. After holding the bottom part the middle hole starts suctioning shown in fig. 10 (c). After that, the SMT machine takes the nozzle to the top of the rubber key. Here already fixed the cords of the key by a computer display. So it can pick the key from the tape [fig. 10 (d)] and place on the PCB [fig. 10 (e)]. Here good friction and deformation effects can be seen.

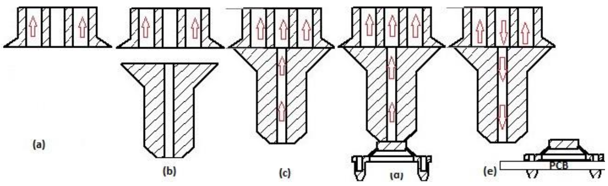


Fig. 8. (a, b, c, d, e) Pick and place Process simulation (Nozzle flow system).

Here is another nozzle 2D simulation [fig. 10 (f, g, h, i, j)] for our project. It has two extra pipes for better suction ability. These two pipes give extra force to suck the holes and push the buttons in the pick and place assembly.

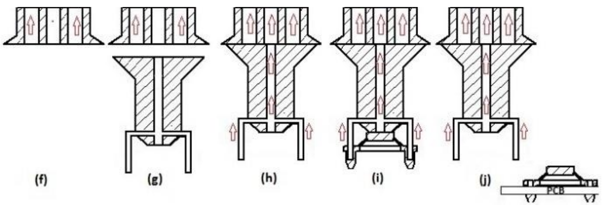


Fig. 9. (f, g, h, i, j) Added two extra pipes in the pick and place Process simulation (Nozzle flow system).

3.1 Tape and packaging

Tape is designed for rubber key packaging. Tape is used here to pack the rubber key. A flexible tape is designed here so that it can roll and the nozzle can pick the key in the automatic assembly process. The tape cave shape and rubber keys base shape relation have effects on the assembly process. The relation between the rubber key and tape- Tape is to pack the rubber key and to pack the rubber key needs the tape. The design of the tape cave is according to the rubber key base dimension So that the rubber key inserts smoothly into the tape cave.

Here a SolidWorks 2D drawing of the rubber key automatic assembly process has been made. Fig. 10 shows the section view of A-A and B-B. And the dimensions of the design. The effect observed is very good. This is the automatic assembly process. The tape cave shape and the rubber key base shape give good effects. Here is shown the dimensions that were used in the design in fig. 11 for better understanding.

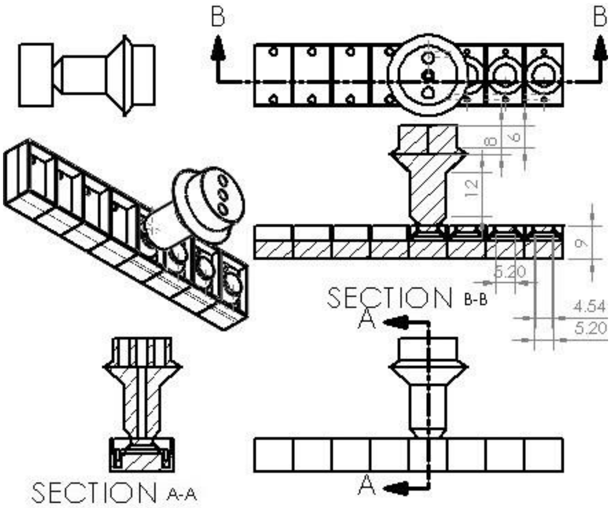
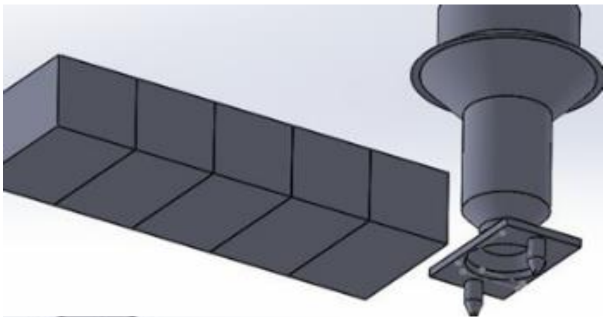
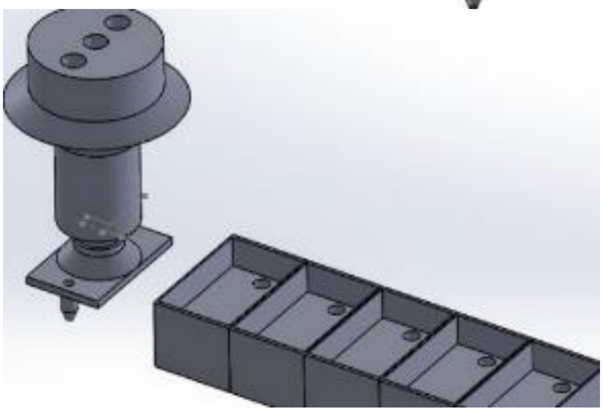


Fig. 10. SolidWorks 2D drawing of rubber key tape and packaging simulation.





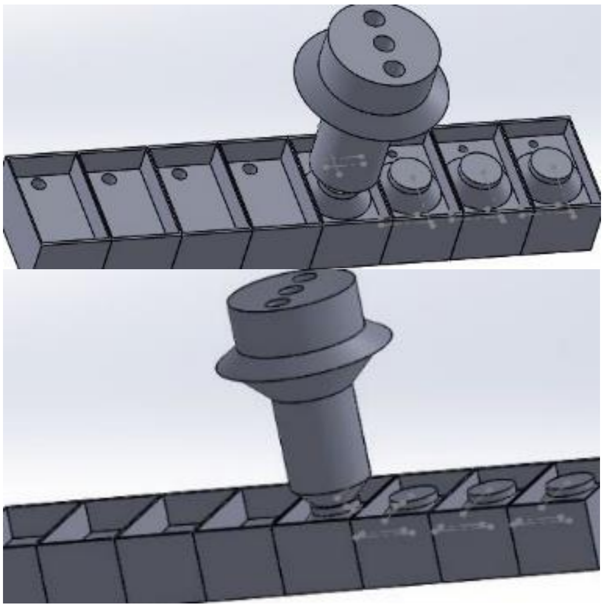


Fig. 11. SolidWorks 3D drawing of rubber key tape and packaging simulation.

3.2 Analysis of the geometric relationship between the tape pit and key rectangular base

Here the dimensions of the tape and rubber key as shown in fig. 11.3 (a) and fig. 11.3 (b). The tolerance is (±0.50).

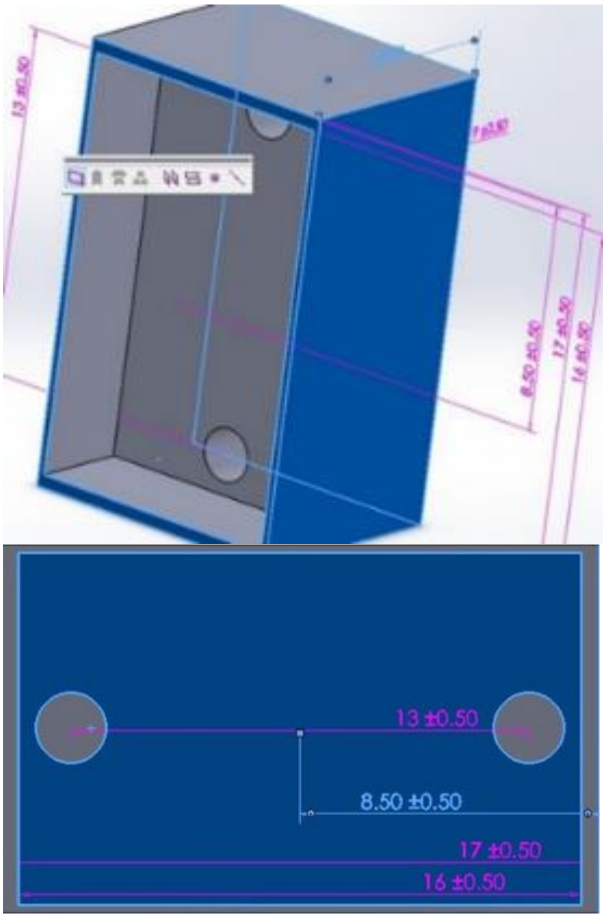


Fig. 12. Rectangular tape dimension.

3.3 Deviation and tolerance

Plastic tape is used to hold the rubber key. If the keys are not well set in the tape, the packaging will face a lot of problems. For example, if the center and angle do not match, the key center and angle also will not match with the center of the tape. So first, need to determine the key base dimension and then get the tape pit dimension. And tolerance is used to fit the key into the tape. The effects and results of the simulation in SolidWorks are good. But the rubber key and tape are not in good positions. Because we know that the more we use low tolerance, our product will have better efficiency.

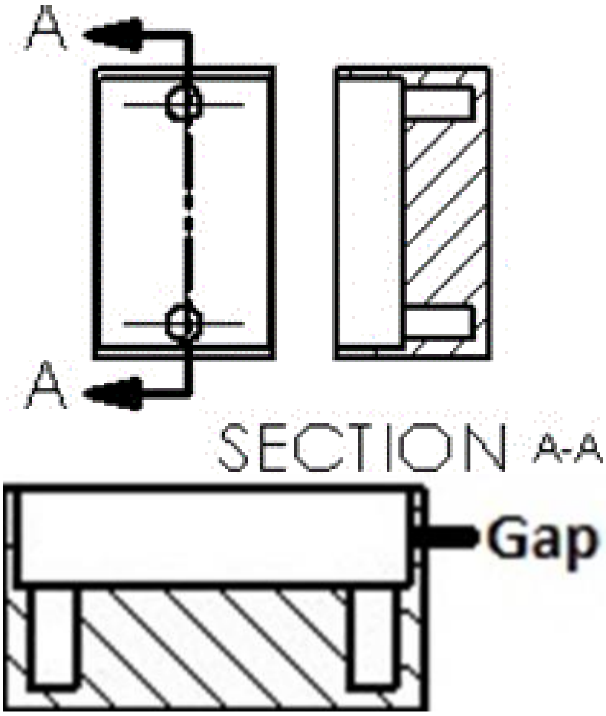


Fig. 13. Shift of center due to the gap.

4. DISCUSSION

The study of flow field over the bluff body has huge contributions in aerodynamic science [6]. From the simulation, we get the angle and center deviation which allows the pin into the hole of the PCB. The gap dimension is 0.5 mm. We have a shift of center due to the gap and deviation of the angle due to the gap. We need to know the angle and center deviation which allows the pin into the hole of the PCB. We give max center and angle deviation.

An engineering and machining allowance is a planned deviation between an actual dimension and a nominal or theoretical dimension, or between an intermediate-stage dimension and an intended final dimension. Tolerance is nothing but an allowable difference between two limits the of same part. Basically, Tolerance is required for manufacturing any part as it is impossible to make it in its exact size.

Here for making the simulation we give a tolerance of +0.5/-0.5mm.

The deviation is the algebraic difference between the actual size of the part and its basic size.

Upper deviation means something added/more than basic size. Whereas lower deviation tends to difference between the minimum limit and basic value of the part difference between the observed value and the actual value is known as deviation.

Tolerance is the total amount a specific dimension is permitted to vary [7]. Here we use 16mm for designing

the rubber key base and tape cave. With tolerance, it is 16 ± 0.5 mm. It means that this dimension value can be between 15.5 mm to 16.5 mm.
From our simulation observed dimension is 16.6 mm then we can say there is a deviation o.1 mm.

5. CONCLUSION

Silicone Dynamics has the capability to assist the silicone keypad needs with free engineering advice for the designs. To make better silicon rubber key structures in this project a better, flexible, reliable, and quick automatic assembly design of rubber keys and nozzle have been made. Silicon keypad is used in the switch for easier and better conductivity.

6. REFERENCES

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