THE LITTLE BROTHER

Written by: Michael Shneider, CTO, Nistec

Is it worthwhile to design electronic board with the smallest electronic component in the world today 008004 and how to do it correctly?

Several months ago, Shahar, a hardware engineer in a hi-tech company that is developing virtual reality headsets approached me: “These are special glasses that can integrate into game consoles in hundreds of millions of homes worldwide” he said with excitement, “this is innovative technology that will enable a totally different viewing and gaming experience than that available at present”. Later in the conversation he stated that at present they are in the midst of developing a central electronic circuit for a project after successful programming has been executed by means of an evaluation board. On the surface it seems promising however he then qualified himself and said that their problem is that as this is a circuit with a wide range of applications on the one hand however on a very small area on the other, there is no room on the board to place all the electronic components. After I received the technical details of the circuit and the components I understood that there is a possibility of executing this assembly on the assumption that we use the smallest electronic component in the world at present, the little brother of the 01005 component; this is a component with dimensions of quarter of a millimetre by an eighth of a millimetre known in the industry as 008004.

The trend that is accelerating in the electronics market of introducing more functions in smaller components does not end only in the field of SMT (Surface Mount Technology) components. The use of electronics over recent years has expanded into a range of applications and accessories. Mobile accessories that are popping up in every corner and the interest surrounding turning inanimate into communicative products (IOT – the internet of things), are forcing an increasing need for realization of more electronic functions on a smaller area. To contend successfully with this challenge it is not sufficient just to produce smaller and smaller components. The dependency and the relationship between the printed

circuit board (PCB), the materials and the production processes obligate in depth analysis of the soldering process and the points of failure already in the planning stage. The producers and the planners of these components are required to work more than ever in close cooperation in order to find creative and no less importantly efficient solutions.

MAXIMUM FUNCTIONALITY ON A MINIMUM AREA

About three years ago for the first time the smallest component in the world started to appear, in serial production, known as 008004. This is a component that has become the little brother of the component that until that time was the smallest component in the category known as 01005. The new component is half the area of 01005 and therefore its use enables significant savings on the circuit area. These components which are for the most part passive components (resistors, capacitors) have particularly small dimensions and weights. The component is invisible to the human eye and its dimensions are: length: 0.25 mm. width 0.125 mm. The height is for the most part 0.125 mm. The distance between the pads of the component is 0.115 mm and the weight of the component is approx. 0.02 mg.

IF IT IS NOT ESSENTIAL, IT IS PREFERABLE NOT TO USE THIS TYPE OF COMPONENT

As a technologist in an assembly plant for printed circuits, I must mention that in principle it is not recommended to use these components, at least at this stage, unless there is no choice and the applications of the circuit obligate choosing these components in order to realize the potential of the product on the area of the circuit required.
Although in our electronics plant in Petach Tikva, Israel, we have executed assembly of many tens of circuits with this type of component with great success (Fig. 1) however one should try as far as possible, within the framework of the constraints of the area, to design the electronic circuit with the bigger brother in the category, the 01005 component, which is much simpler and easier for assembly and maintenance.
Hereinafter are several challenges in working with the 008004 type of component:

1. It is not possible to repair this component manually – as a result of the small area of the component and its negligible weight it is not possible to solder this component

with a soldering iron. Therefore, one should take into account that after soldering the board on the automatic assembly line it is not possible to repair the component manually. In the event that we want to repair/add to this component after soldering we will be forced to reassemble the board.

2. Particularly accurate application of the soldering paste – one of the most important detail for the success of soldering the SMT component is the correct application of the soldering paste. This is even more important for tiny components such as type 008004. A particularly thin application stencil should be used (0.075 mm/3 ml) and the openings of the stencil should be designed pursuant to the recommendation of the manufacturer of the components. It should be stated that there could be different recommendations for different components, although they are of the same size.
3. Uniformity of the rest of the components on the board – as the component requires accurate and delicate work during the soldering the rest of the components on the circuit should be selected meticulously. The variety of the types of the components on the circuit should be reduced in order to enable uniformity and thermal balance during the soldering process. For example: in a circuit that contains a 008004 component one should not also integrate a larger and heavier BGA component.
4. Selective choice of producers of circuits/circuit components – as this is an advanced technology there are very few electronic factories that are capable of successfully assembling this type of components. Therefore, selection of an 008004 type of component enforces work with a reduced number of elite producers that are compatible with the technology.
5. High price – the price of the 008004 component is 50% more expensive than the larger components in the category. However, in the coming years the use of the component will increase and the price will balance out with the rest of the components in the market.

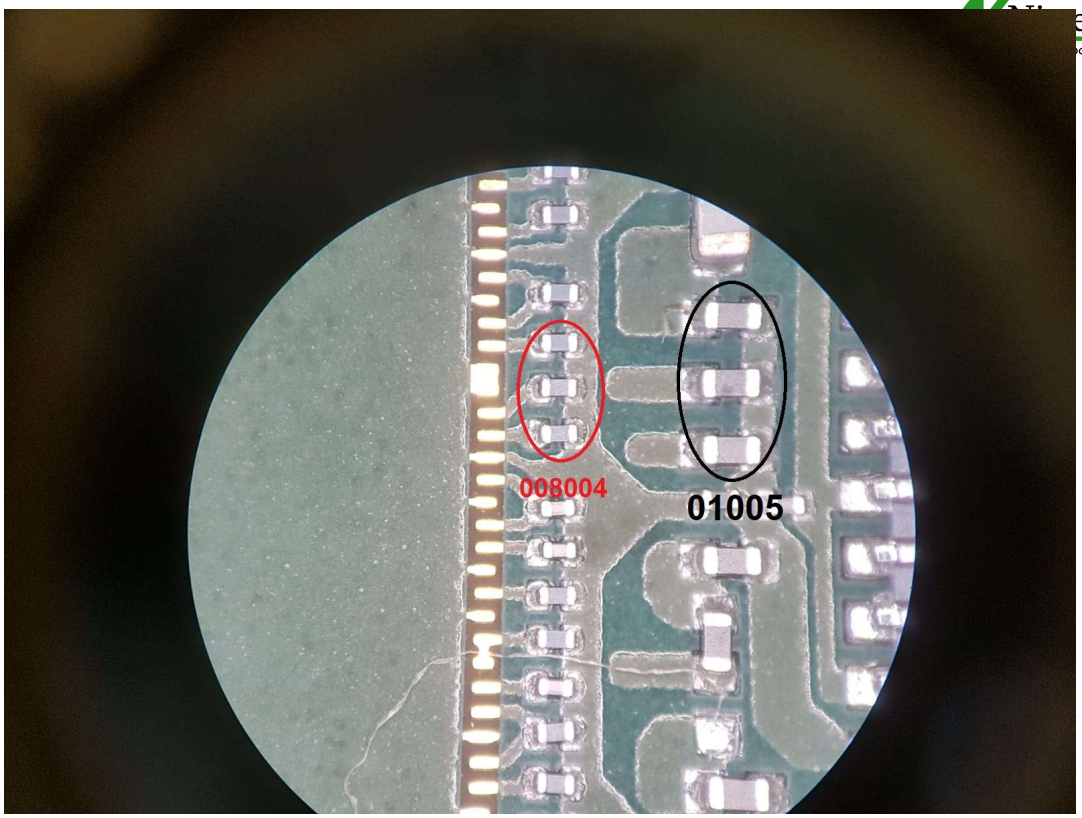

Fig. 1: A printed circuit with the 008004 type electronic component and alongside it a 01005 type electronic component – the circuit was assembled at the Nistec Center plant in Petach Tikva, Israel (the photograph was taken by means of a microscope with a magnification of 1:40)

The key to good quality assembly of an 008004 component is accurate application of the soldering paste. One should ensure very accurate application of the solder paste. The maximum deviation is 50 microns (0.05 mm).
In the assembly process attention should be paid to several recommendations:

- Define the component footprint pursuant to the component manufacturer recommendations.
- Make an opening for the solder paste in a ratio of 1:1.
- Define the pads for the 008004 component without release of the solder mask. That is with a SMD (solder mask defined) configuration and not as is customary for NSMD (non solder mask defined) components. Furthermore ensure that a solder mask is defined between the pads.
- Maintain a minimum distance of 6 ml between two adjacent 008004 components.

Soldering an 008004 component in a process which is unsound could lead to a significant number of quality malfunctions. Common malfunctions in assembly of the 008004 component are for example:

1. Component lifting (tombstone) – the component could lift during the assembly process. This could take place mainly due to deviations in the application of the solder paste and also due to imprecise placement of the component on the pads.

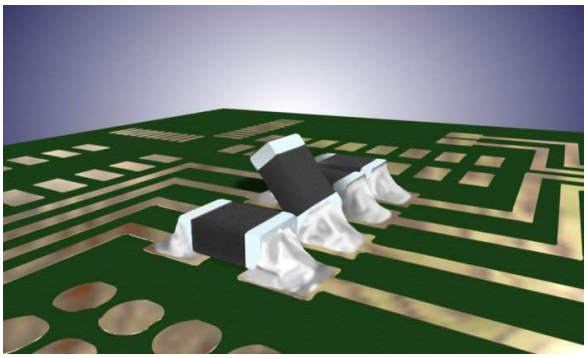

Fig. 2: Possible malfunction in assembly of a 008004 component – tombstone

2. Shorts (bridging) – the component could attach to the adjacent component and cause a short. The reason is inaccuracy in the application process or the positioning.

Fig. 3: A possible malfunction in assembly of an 008004 component – bridging

POSSIBLE AND CHALLENGING

In the light of the trend for increasing functionality of electronic products and at the same time decreasing their size, electronic circuits are becoming more and more anticipated. An 008004 component in the light of its minimal area and weight could be an excellent solution for contending with these challenges. Although soldering of the component obligates contending with several complex technological challenges, nevertheless with the help of correct definition of the component during the assembly, meticulousness of a controlled assembly process it will definitely be possible to achieve better quality soldering results. For Hardware Engineers developing these products, these components can be simply little gifts for big dreams.