The Eurasia Proceedings of Science, Technology, Engineering & Mathematics (EPSTEM)
ISSN: 2602-3199

The Eurasia Proceedings of Science, Technology, Engineering & Mathematics (EPSTEM), 2024

Volume 32, Pages 336-341

IConTES 2024: International Conference on Technology, Engineering and Science

Automation of IMEI Label Attachment Process in Mobile Device Production

Okan Temizturk
Samsung Electronics Türkiye Production

Kaan Pehlivan
Samsung Electronics Türkiye Production

Abstract: The methods of sticking labels on products produced in mass production facilities can vary greatly depending on the type of product to which the label will be attached, the size of the label and the level of adhesion of the label. The suitability and performance of the label sticking method vary greatly depending on the size of the label and especially the level of adhesion of the label. In particular, the correct selection of the method of sticking labels with low adhesion to products in mass production lines significantly affects the accuracy of the sticking process, the quality and performance of the sticking process. Some mobile phone manufacturers deliver mobile phones to users with a label attached to the back of the device. This label contains IMEI number information and a QR code for the IMEI number. The code on this IMEI label is read by barcode scanners to manage production processes and applications in the production process. Depending on the country where the mobile phones will be sold, this label can be removed before the packaging process before being sent to the user, or it may be desired to send the user with the IMEI label attached to the mobile phone. In case this label is requested to be removed for various purposes, the label size is designed to be both very small and easy to remove by keeping the adhesive level low in some countries. The fact that the IMEI label is small and has a low adhesive level requires the most appropriate selection of the attachment method in mass production facilities. This article will discuss the most appropriate adhesive method for low-adhesive and small-sized IMEI labels.

Keywords: IMEI label, Label attachment, Label attachment automation,

Introduction

Each mobile phone has its own information, such as the manufacturer, model, IMEI code, S/N code, network access permission, etc., which are implanted in the mobile phone at the factory or pasted on the mobile phone cover, generally the position of the back cover. It is very important whether the information is accurately pasted to the designated location before leaving the factory, and whether the pasting quality meets the requirements. To meet these requirements, various bonding methods are applied in today's production processes. The choice of these application methods may vary due to factors such as the size of the label to be attached, the level of adhesion or the geometry of the bonding zone. As an application method, the methods of IMEI label adhesion process can be analyzed under the following three headings.

Label Attachment Methods

In today's industry, there are various methods of attaching low-adhesive labels to products. Labels can be attached to the desired areas of the products with different methods. These attaching methods can vary according to the size of the label, its level of adhesion and the level of production speed to meet the needs. Labels can be stuck manually in cases where the geometry of the product is complex, there is no need for an

automated attaching process at current production speeds or the precision of the attaching position of the label is not required, or due to requests such as performing a fast and effective sticking process in accordance with the production speed to a certain shade of the product or completing the sticking process with better quality. Labeling methods can be examined under 3 headings.

Manual Label Application

Though it may seem outdated in an era of automation, manual label application is still prevalent, particularly in small-scale production settings or when dealing with complex products. Manual application allows for flexibility that mechanical methods cannot easily replicate. Workers can inspect each product for quality control, ensuring that labels are applied correctly and securely. However, this method can be labor-intensive and may hinder throughput. In industries where precision is of vital importance, manual labeling may not provide the expected precision, accuracy and quality to the desired extent, and in such cases, manual labeling is at a disadvantage when compared to other labeling methods.

Semi-Automatic Labelers

Semi-automatic labelers strike a balance between manual labor and full automation. Operating typically with an operator overseeing the process, these machines require some manual input but are designed to speed up the labeling process considerably. An example includes labeling machines that allow workers to place items on the conveyor and the machine applies the label. This method reduces the time taken for label application while still involving human oversight to ensure accuracy. This method can be used especially in cases where a fully automatic label attachment system cannot be installed but the label needs to be applied precisely to a specific area of the product.

Fully Automatic Labeling Systems

In mass production settings, fully automated labeling systems represent the cutting edge of efficiency. These systems are programmed to apply labels in a consistent manner at high speeds, which is essential for large-scale operations. Conveyor belts transport products through a series of automated stations where labels are printed, cut, and applied, all in a matter of seconds. Fully automatic systems are particularly beneficial for manufacturers expecting high volumes of products, ensuring that each item is labeled precisely while minimizing the risk of human error.

In mass production facilities, all three application techniques mentioned above can be used as an application. However, in terms of both production efficiency and accuracy and precision of the labeling process, the most suitable method in mass production facilities is the systems where the labeling process is carried out using a fully automatic system.

IMEI Number

IMEI (International Mobile Equipment Identity) is a unique 15-digit serial number given to every mobile phone which can then be used to check information such as the phone's Country of Origin, the Manufacturer and it's Model Number (Samsung, 2024). IMEI is a unique number to identify mobile phones and satellite phones over diversified network of GSM, Universal Mobile Telecommunications System (UMTS) and Long-Term Evolution (LTE) network (Roa, 2015). These IMEI numbers are stored in a database called the EIR (Equipment Identity Register), which contains information about all valid mobile phone equipment.

The IMEI number reveals details about a phone without having to physically have it, including the brand and model, year of release, and other specifications. Most phones have a very simple key-in method to retrieve IMEI/MEID numbers, enter a 5-digit string—*#06#—and the number will be displayed on phone(Sahni, 2014). It is also printed by laser on back cover or printed on the label which is attached on back cover of the mobile device's to keep the IMEI number safe if it is needed. Another way to learn IMEI number is checking the package. The sticker with the IMEI code number is placed on the box with the phone (Davronbekov 2019).

Method

Attachment of Low Sticky Label in Automation Line

In mobile phone production facilities, there are many processes carried out with full automation systems during the production process. Many of the operations performed with these full automation systems need to be done precisely by targeting the correct position. One of the processes that must be done precisely in mobile phone production facilities is the process of sticking the IMEI label to the correct position on the phone fully automatically. This label also has an IMEI number QR code, which is read by scanners at many stages of the fully automated production process. In order for the barcode scanning of this label to be carried out accurately, the labels must be precisely attached to each phone in the correct position. The fully automatic equipment has been developed to fulfill the desired process accurately and precisely eliminates human error and performs the process of precisely sticking each label in the correct position. The fully automatic IMEI label sticking machine is able to meet all requirements accurately and with the same quality.

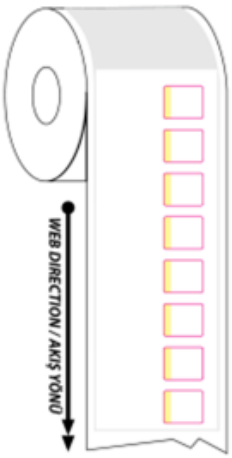

Figure 1. IMEI label Roll

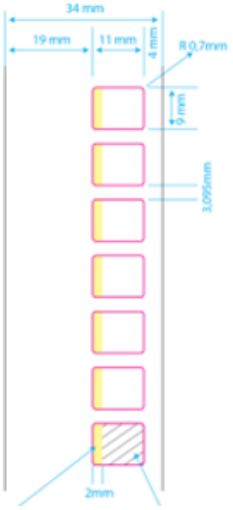

Figure 2. IMEI label dimensions

Figure 3. Actual IMEI label roll

In above picture (Figure 1) it is shown that IMEI label and the roll on which the IMEI label is wrapped in Samsung Electronics Turkiye Production Company. IMEI label dimensions (Figure 2) which (9mm x 11mm) is smaller than 1 cm2 area make it difficult to apply common sticky label attachment processes which are generally applied in industries. One of the most commonly using sticky label attachment process is taken place as peeling partially label from their roll and make contact between product and label which is partly peeled from its own roll (Figure 3). After this contact of the sticky label to product, the product continues to move along the conveyor belt and the label continues to attach to the product as it moves along the belt, and the attaching process is completed. However, this attaching method is quite difficult to apply for labels that are small in size and have low adhesive levels. This widely used attaching method makes things quite difficult, especially when labels need to be attached to a specific location on the product with high accuracy, such as in the attaching process of IMEI labels. For this reason, the peeling/vacuuming technique comes to the fore and gives better results in order to correctly stick small IMEI labels with low adhesive level onto the mobile phone.

In the peeling/vacuuming technique, in the first stage, labels are partially peeled off (Figure 4 & Figure 5) from the rolls they are wrapped in. Then, a vacuum head comes to the peeled part (Figure 6 & Figure 7) of this peeled IMEI label and starts vacuuming. Then, the IMEI label peeling process continues with the help of the peeling mechanism (Figure 8 & Figure 9) Thus, while the IMEI label is peeled off, it is held by vacuuming with the help of the vacuum head. Then, this vacuum head is directed towards the area where the IMEI label is desired to be attached with the help of pneumatic pistons (Figure 10 & Figure 11). When the phones moving on the conveyor belt reach the appropriate position for the IMEI label to be attached, the conveyor belt is stopped and the vacuum head holding the IMEI label moves towards the mobile phone and presses on the surface where the IMEI label is attached for at least one second (Figure: 12 & Figure 13), helping the adhesive to hold better on the label. In addition, during the pressure of the vacuum head on the mobile phone, the vacuum holding the IMEI label is disabled and air is blown through these vacuuming holes to ensure better adhesion of the label.

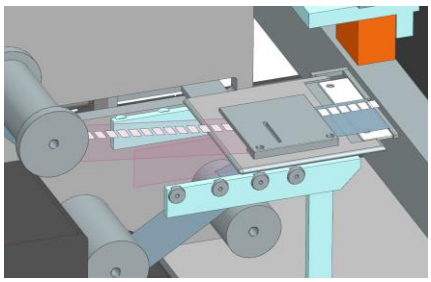

Figure 4. IMEI label partially peeling

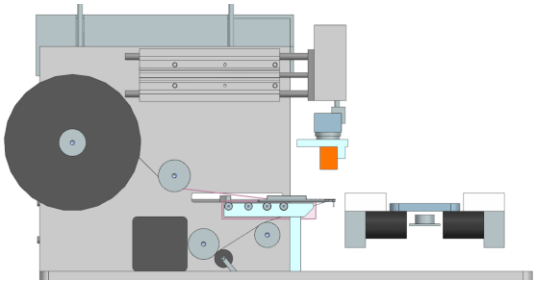

Figure 5. IMEI label partially peeling side view

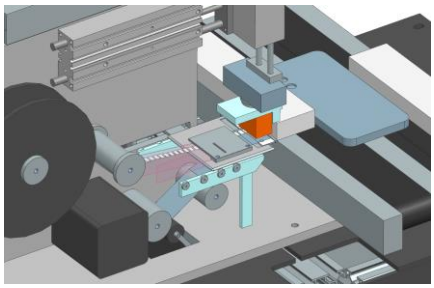

Figure 6. Vacuum head vacuum start position

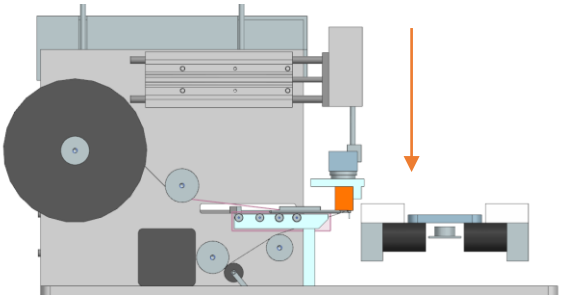

Figure 7. Vacuum head vacuum start position side view

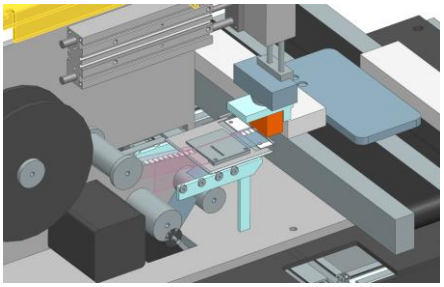

Figure 8. Label peeling mechanism move back

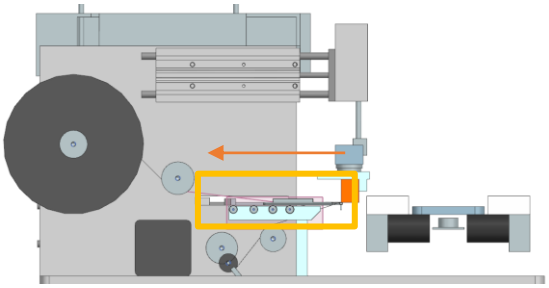

Figure 9. Label peeling mechanism move back side view

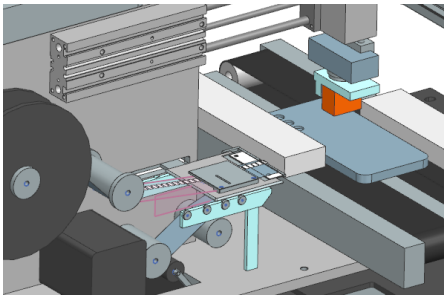

Figure 10. Label peeling mechanism moving back

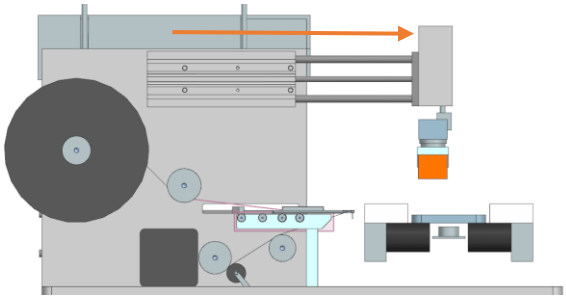

Figure 11. Label peeling mechanism motion side view

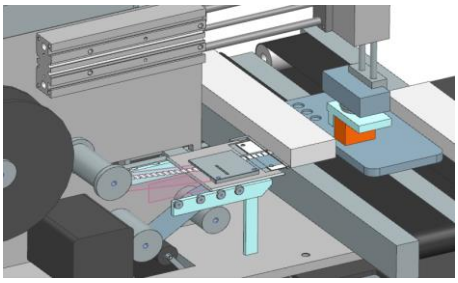

Figure 12. Label attachment position

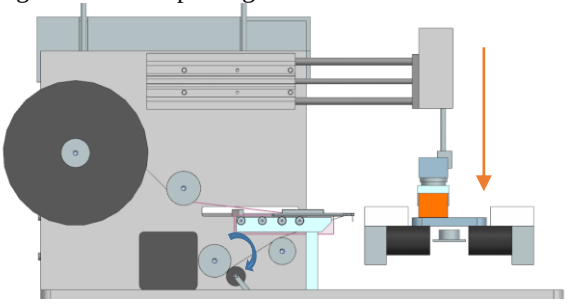

Figure 13. Label attachment position side view

Thanks to the 180-degree rotation feature of the piston to which the vacuuming head is connected, which vacuums the IMEI label, labels can be attached to the desired area in the desired direction and at the desired angle. At the same time, with the help of a barcode reader placed in the IMEI label sticking area (Figure 14), it is checked whether there is already a label on the existing mobile phone before the IMEI label sticking process in order to prevent label printing on top of each other. If the IMEI label is detected with the help of the barcode reader, the IMEI label is not printed on the mobile phone and the mobile phone is advanced on the conveyor belt for the next processes.

After the IMEI label is peeled with the help of the vacuum head that peels the label, it is compressed and pulled forward with the help of two cylinders so that the next IMEI label can be peeled by the vacuum head. If the sensor at the end of the label peeling mechanism detects a label during the label peeling process, the peeling process is stopped and thus the IMEI label is brought to the correct position for the next vacuuming process. The IMEI roll is compressed with the help of a cylinder connected to a stepper motor and a cylinder connected to a piston (Figure 15) and the label roll is pulled for the next process by the rotation of the cylinder of the stepper motor and the IMEI label is brought to the correct position for the vacuuming process. A fully automated equipment that can perform Peeling/Vacuuming functions at the correct timing can automatically perform the IMEI labeling process in mobile phone production facilities. (Figure 16)

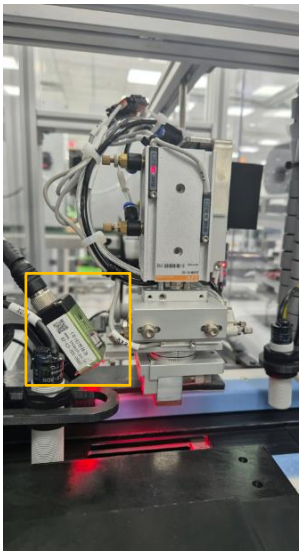

Figure 14. Barcode Scanner

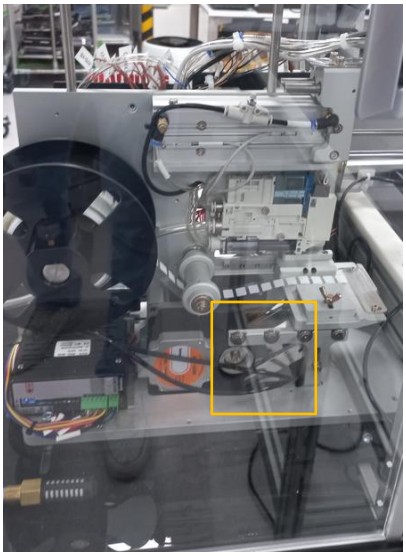

Figure 15. Pulling mechanism of roll

Figure 16. Automation Machine

Results and Discussion

By using the peeling/vacuuming technique, small-sized and low-adhesive IMEI labels can be correctly and safely attached to mobile phones. In addition, by using a barcode scanner, it is possible to check whether there is an IMEI label on existing mobile phones, thus preventing existing errors and the problem of attaching labels on top of each other. The most efficient way to properly attach the IMEI label to the correct location in mass production lines is the peeling/vacuuming method. This process is suitable for production lines with a tact time of more than 3 seconds. In lines with much faster tact times, methods that will provide faster sticking should be preferred.

Conclusion

There are many label attachment methods in mass production facilities. However, the current widely used label attaching methods do not provide the desired results for small-sized and low-adhesive labels such as IMEI labels. The most suitable method for these types of labels in mass production lines is the peeling/vacuuming method. Thanks to the Peel/Vacuum method, labels can be attached to the desired area of mobile phones in the most accurate way. Unlike other label attachment methods, the best and most efficient results were obtained with the peel/vacuum technique in the application of small labels with low adhesiveness, such as IMEI labels.

Recommendations

In the Peeling/Vacuuming method, it takes a certain amount of time to peel the label from the roll and move it between the axes with pneumatic pistons. In addition, in the IMEI label attaching process, the vacuum head applies pressure to the IMEI label for about one second to increase the strength of the bonding process. All of these processes take more than 3 seconds to complete. This method is not recommended for mass production lines with a tact time of less than 3 seconds.

Scientific Ethics Declaration

The authors declare that the scientific ethical and legal responsibility of this article published in EPSTEM Journal belongs to the authors.

Acknowledgements or Notes

This article was presented as an poster presentation at the International Conference on Technology, Engineering and Science (www.icontes.net) held in Antalya/Turkey on November 14-17, 2024.

References

Davronbekov, D. A., Isroilov, J. D. & Akhmedov, B. I. (2019). Principle of organizing database ıdentification on mobile devices by IMEİ. *International Conference on Information Science and Communications Technologies (ICISCT)*, Tashkent, Uzbekistan, pp. 1-5

Rao, S. P., Holtmanns, S. Oliver, I. & Aura, T. (2015). Unblocking stolen mobile devices using SS7-MAP vulnerabilities: exploiting the relationship between IMEI and IMSI for EIR Access. *IEEE Trustcom/BigDataSE/ISPA*, Helsinki, Finland, pp. 1171-1176.

Samsung. (n.d.). *Smart phone: How do I locate my phone IMEI number?* Samsung New Zealand. Retrieved October 31, 2024, from https://www.samsung.com/nz/support/mobile-devices/smart-phone-how-do-i-locate-my-phone-imei-number/?srsltid=AfmBOoq5WbpH7jplr3Q7pYwJz-4H-j_WVWgDBq9Vz-9LAFQwfVXNChwa

Sahni, M. (2014). Detectıng and automated reportıng of change in IMEI Number. *International Journal of Advancements in Research & Technology, 3(*5), 186-188.

Xibin, W., Junhong, W., Wenbin, C., Yuran, W., & Nan, W. (2020, November). Mobile phone label online detection system based on machine vision. In *2020 Chinese Automation Congress (CAC)* (pp. 1784-1787). IEEE.

Author Information

Okan Temizturk
Samsung Electronics Turkiye Production
Mimar Sinan mah. 103. Cad No:72
Kapaklı /Tekirdağ / Türkiye
Email: o.temizturk@samsung.com

Kaan Pehlivan
Samsung Electronics Turkiye Production
Mimar Sinan mah. 103. Cad No:72
Kapaklı /Tekirdağ / Türkiye

To cite this article:

Temiztürk, O. & Pehlivan, K. (2024). Automation of IMEI label attachment process in mobile device production. *The Eurasia Proceedings of Science, Technology, Engineering & Mathematics (EPSTEM), 32,* 336-341