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Mechanical Auto Booting on Production Lines

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Abstract: Auto-booting is the process of automatically turning on an electronic card. The aim of this study is to transform the auto-booting process from a software to a mechanical process and to analyse and sample the benefits of this process. In this context, 5 samples were carried out in the Samsung Electronics phone production facility and the aim was to change the opening process of the phones to a mechanical process, various studies were carried out and trial productions were carried out. The ppm target and tact time were used as a reference to test the hypotheses. The results of the study showed that the mechanical opening of the phones reduced the tact time and minimised the possible errors.

Keywords: Electronic card, Tact time, Auto booting, Ppm

Introduction

In modern manufacturing and computing environments, efficiency and rapid response times are crucial. One method to achieve this automation is by utilizing AT commands to streamline the booting process.AT (Attention) commands are a set of instructions used for controlling modems and other devices. While traditionally employed in telecommunications, AT commands can be adapted for various devices including embedded systems, enabling users to manage tasks efficiently. These commands are especially useful for initiating boot processes in devices automatically. To implement auto booting through AT commands, the first step involves configuring the device firmware to recognize the commands. In today's fast-paced manufacturing landscape, optimizing production lines is crucial for maintaining competitiveness. One of the innovative solutions that have been gaining traction is the Mechanical Auto Push system. This technology significantly enhances production efficiency and decreases tact time, which is vital for meeting today's demanding market requirements.

Tact time is the time available to produce one unit of product in order to meet customer demand. In a world where speed and efficiency are paramount, minimizing tact time is essential. The Mechanical Auto Push technology is engineered to optimize this measurement by ensuring that every segment of the production line operates smoothly and according to rhythm. For instance, if a factory needs to produce 600 units in eight hours, the required tact time would be 48 seconds per unit. By implementing Mechanical Auto Push systems, manufacturers can automate repetitive tasks, allowing for a more consistent flow that meets or exceeds this pacing. This technological integration not only enhances output but also maintains quality control by reducing the chances of product mishandling.

Mechanical Auto Push refers to a system designed to automate the movement of items through production lines. It simplifies the process of transferring products between different stages of production without the need for manual labor. This reduces human error and increases speed, making it an integral component in both assembly and manufacturing environments.

Auto Push

1. Increased Efficiency: The most immediate advantage of Mechanical Auto Push technology is its ability to speed up the entire production process. By automating the opening time of phones products, companies can reduce labor costs and increase throughput.
2. Consistency in Production:Machines operate with a predictable precision that humans cannot always match. Implementing a Mechanical Auto Push system ensures that products move through the production stages without delays or inaccuracies, thereby enhancing overall quality.
3. Reduced Labor Costs: While initial investment in automation may seem significant, the long-term savings are substantial. With machines handling the more mundane aspects of production, businesses can redirect human resources toward roles that require creativity and critical thinking.
4. Flexible Integration: Mechanical Auto Push systems are versatile and can be integrated into various types of production lines. Whether a factory is producing automotive parts, electronics, or consumer goods, these systems can be tailored to meet specific needs, enhancing overall productivity.

Takt Time

Cycle time was originally used to design the work content of operators (Monden, 1998). The term "Tachzeit" comes from the German word "takt" which refers to rhythm and meter in music. In manufacturing, it refers to the speed at which a product is produced.(International Automotive Manufacturing)(Cochran, 1999). Takt times can be as long as days. An aircraft manufacturer, for example, uses a takt time of 4 days (Chao, & Graves, 1992). Takt time represents the average pace of sales over a specific time period. It defines the time available to pro-duce one part (Shingo & Dillon, 1989). It is the overall availableproduction time in a chosen time interval divided by the overall forecasted customer demand for the time interval. The definition is as follows;

Takt Time = Time Available / Avarage Customer Demand per Time Period
Time Available = Total Time – (Maintenance Time + Time Allowances)

The following steps are necessary to calculate takt time:

1. Define the time interval, for which the takt time needs to be calculated
2. Determine the available time per shift
3. Define the customer(s), whose demand needs to be satisfied
4. Determine the demand forecast for the chosen time interval

AT Command

1. Firmware Configuration: Ensure that your device's firmware supports AT commands. This may involve loading a suitable firmware version or modifying existing firmware.
2. Create an Auto Boot Script: Develop a script composed of various AT commands that the device will execute during the boot-up phase. This could include commands for initializing hardware components, connecting to networks, or running diagnostics.
3. Test Commands Individually: Before automating, run each command independently to ensure they execute as expected without errors.
4. Combine Commands into a Sequence: Once verified, arrange the series of commands that you want to execute in the correct order. This sequence will be crucial for a smooth booting process.
5. Set Trigger for Boot: Identify a physical trigger (like a button press) or a timing mechanism (like a timer) that will initiate this sequence of AT commands automatically.

Implementing an auto boot process through AT commands provides several advantages:

- Reduced Tact Time: This is the total time taken from one production unit to the next. By automating booting, manufacturers can significantly decrease the time taken for devices to become operational, thus improving overall productivity.
- Enhanced Precision: Automated processes minimize the likelihood of human error. The use of AT commands ensures each device undergoes the necessary initialization steps every time it boots.

- Consistent Performance: Devices booting through an automated process maintain consistency across multiple cycles. This reliability is critical in production settings, where any inconsistency can lead to defects or inefficiencies.

PPM

Part Per Million (PPM) is a quality metric often employed to gauge defects or errors in processes. To calculate PPM in the context of booting, one must:

1. Define the Sample Size: Determine the number of devices booted in a specific timeframe.
2. Count Boot Errors: Log the number of devices that fail to boot correctly.
3. PPM Calculation: Use the formula:
   \[
   PPM = \left(\frac{\text{Number of Defective Units}}{\text{Total Units}} \right) \times 1,000,000
   \]

By tracking PPM closely, manufacturers can identify issues in the auto booting process and make necessary adjustments to minimize failures. PPM is an expression of one millionth of a whole, but technically the use of this acronym is incorrect. According to technical standards ISO 80000-1, Article 6.5.5 the correct expression is in powers of tenths. Calculation of this dimensionless number is used in manufacturing and other companies to monitor non-conforming parts, the quantity of nonconforming products from a single batch or in the monitored period divided by the total number of units in the same batch or during the monitoring period, and then multiplied by 10^6

PPM= (ND/NS)*1 000 000(Bebr et al.,2017)

Where: ND - number of defect units; NS - number of supplied units As can be seen from the above formula ppm is used as an indicator for comparing production efficiency, supplier performance, or to compare businesses, etc(Bebr et al.,2017)

Setting up an automated booting process using AT commands is a powerful way to enhance productivity, reduce tact time, and ensure consistent performance in any manufacturing environment. By leveraging these commands, businesses can create efficient, error-resilient systems that lead to better overall quality and performance metrics. Implementing these methods effectively can revolutionize operations, paving the way for a more automated and efficient future.

The Mechanical Auto Push technology represents a significant leap forward in manufacturing processes. By decreasing tact time and enhancing overall production efficiency, it addresses some of the most pressing challenges in modern manufacturing. As industries continue to innovate, the adaptation of such technologies will be paramount in achieving sustainable growth and productivity.

Method

Auto Booting with IF Pack

The AT command method is a system that enables commands to be sent to the PBA via the IF Pack, which then facilitates the phone's operation. The IF Pack is a transfer cable equipped with a USB-C connector. Once the phone is fully set up, booting is initiated by executing the AT command using the IF Pack during the initial testing process, allowing the phone to power on. Due to the lengthy process of opening the phone, this step was initially transitioned to the Auto Screw section.

The assembly process for the IF Pack Type C is accomplished by utilizing the auto screw method during pressing, thereby enabling the AT command procedure. Although this adjustment reduced the tact time during the initial attempt, it led to an increase in overall defects, with the IF Pack causing damage to the USB area. The defect rate was recorded at 35 per 1,000 pieces, equating to 35,000 parts per million (ppm) in Table 1.

Table 1. Samples of Samsung

Variables		Product	Defect Ppm
Group	1.	1000	35000(%3.5)
	2.	10000	0(%0)
	3.	10000	0(%0)
Model	Rear Back Cover	10000	0
	Auto Screw	10000	0
	Press AT Command	1000	35000

Results and Discussion

Mechanical Auto Boot on Auto Screw

5 phone models were tested for auto-boot processes. In PD chargers where the software boot process is applied using the AT command method, the phone boot process is performed using the IF Pack input. IF Pack input and output time: 1.6 s + AT command time: 0.4 s = 2 s is defined as the processing time. The average opening time of a phone is 43 seconds. The pressing time of the mechanical process is 4 s and 6 ports perform the same process; the pressing process is completed in 7,3 second on average. A similar process takes place with the Auto Screw process and the average screw time for models with full backs is between 40 and 50 seconds. The mechanical booting is that we added 1 button (Figure 3.) of the autoscrew fixture when close the autoscrew cover, a boot button and split power switch while this push on phone in turn presses. Not require any software operation at all but boots up by user interaction with both physical buttons.ones.

This has been tested on 10000 phones, without any error and failure rate has result as 0 ppm As Samsung uses 2 types of housings to make phones, Auto Screw is not well-supported. Because we needed a sustainable answer, so 2 types has to be separated and also need that why cases lives in dark areas. Full Set Rear model: With this model, the Full Set is attached to the phone and there is a power button on it. Auto screw process initiates and mechanical booting can be performed once full set is fitted. Top / Bottom Rear Antenna Model: There are 2 antennas and this models use a Rear Press Jig (Figure 1.) but since the power key is on the back cover for auto screw-on wiring it cannot be done in mechanical boot. To solve this, the button (Figure 2.) was planned to drive on, press taking advantage of a place for another botton in suitable location during back cover pressing action- and turn-on phone as experiment were conducted over failure rate causes detection & deformation. As a result of 10000 units of production, no error was found and the process was developed for all Samsung models.

1. Material Selection: The choice of materials for the button body and internal components plays a crucial role in durability and user experience. Common materials include plastic, metal, and composites. Each has its pros and cons regarding weight, cost, and resilience to wear and tear.
2. Ergonomics: The design should prioritize ease of use, ensuring that the button is intuitive and comfortable to press.
3. Sensitivity and Feedback: Mechanical push buttons must provide immediate feedback upon activation to reassure users that their action has been registered. This can be achieved through tactile and auditory cues, enhancing user satisfaction.
4. Environmental Factors: Consideration of where the push button will be used is essential. For example, buttons exposed to moisture or dust need to have protective seals to maintain functionality over time.

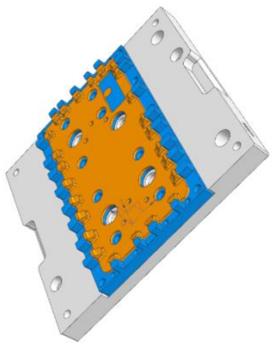

Figure 1. Without booting button

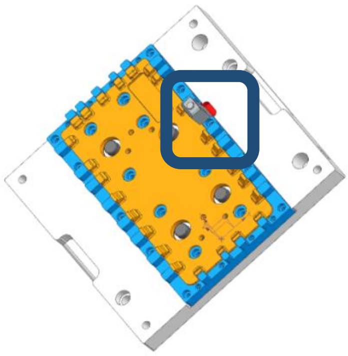

Figure 2. Implemented booting button

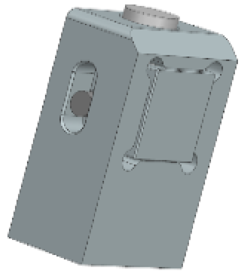

Figure 3. Booting button

More efficient results were obtained compared to the AT Command process and a total of 1 man-power/2 shift was gained during this process. Although the model classifications are very variable, mechanical booting was found to be more functional and effective in all areas.

Conclusion

When all the data was evaluated, the mechanical boot process was found to be suitable for lower error rates and longer use. It was found to be efficient and possible in terms of applicability to the existing production order and production lines. As a result of the visual and functional tests performed on 5 different phone models used in this study, the mechanical boot process can be preferred over other alternatives in phone production lines.

Recommendations

All production lines can be considered suitable for similar line developments and harmonization improvements, and similar ones can be tried in test productions. Their efficiency can be tested by evaluating them within the established takt time, ppm rate and LOB limits and, if appropriate, implemented. In production lines based on operating performance, it will be more effective to use mechanical booting with mechanical and durable material selection.

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

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