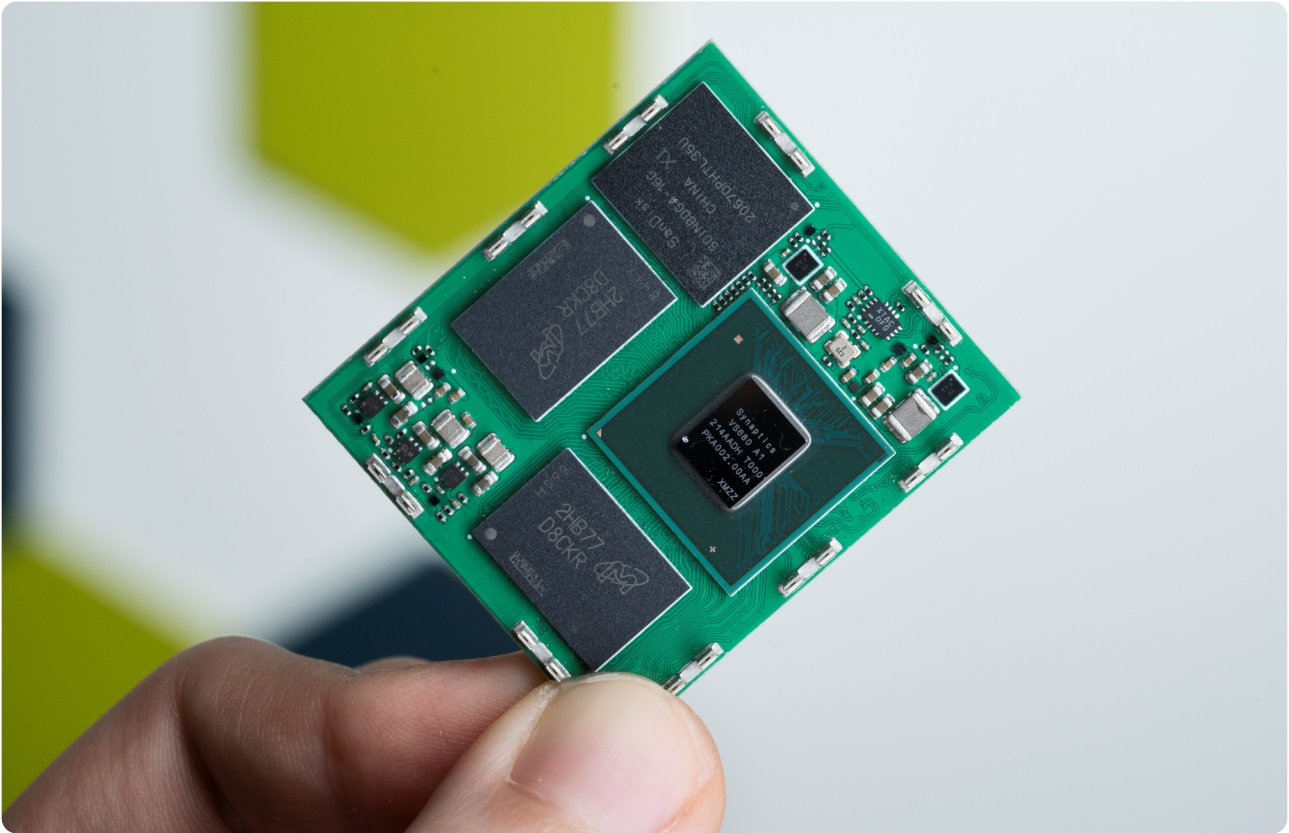


# Grinn PCB Failure Detection Whitepaper

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# 1 | Features

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## AI-Powered PCB inspection

Uses advanced AI algorithms to ensure layout accuracy and solder joint quality



## Seamless robotic coordination

Interfaces with robotic arms for efficient PCB handling



## Intelligent conveyor integration

Works with infrared sensors to optimize inspection timing



## Precision image processing

Captures 640x480 images for defect analysis with an optimized AI model



## Real-time defect visualization

Highlights errors with color-coded indicators for quick assessment



## Live process monitoring

Streams camera feed for immediate oversight

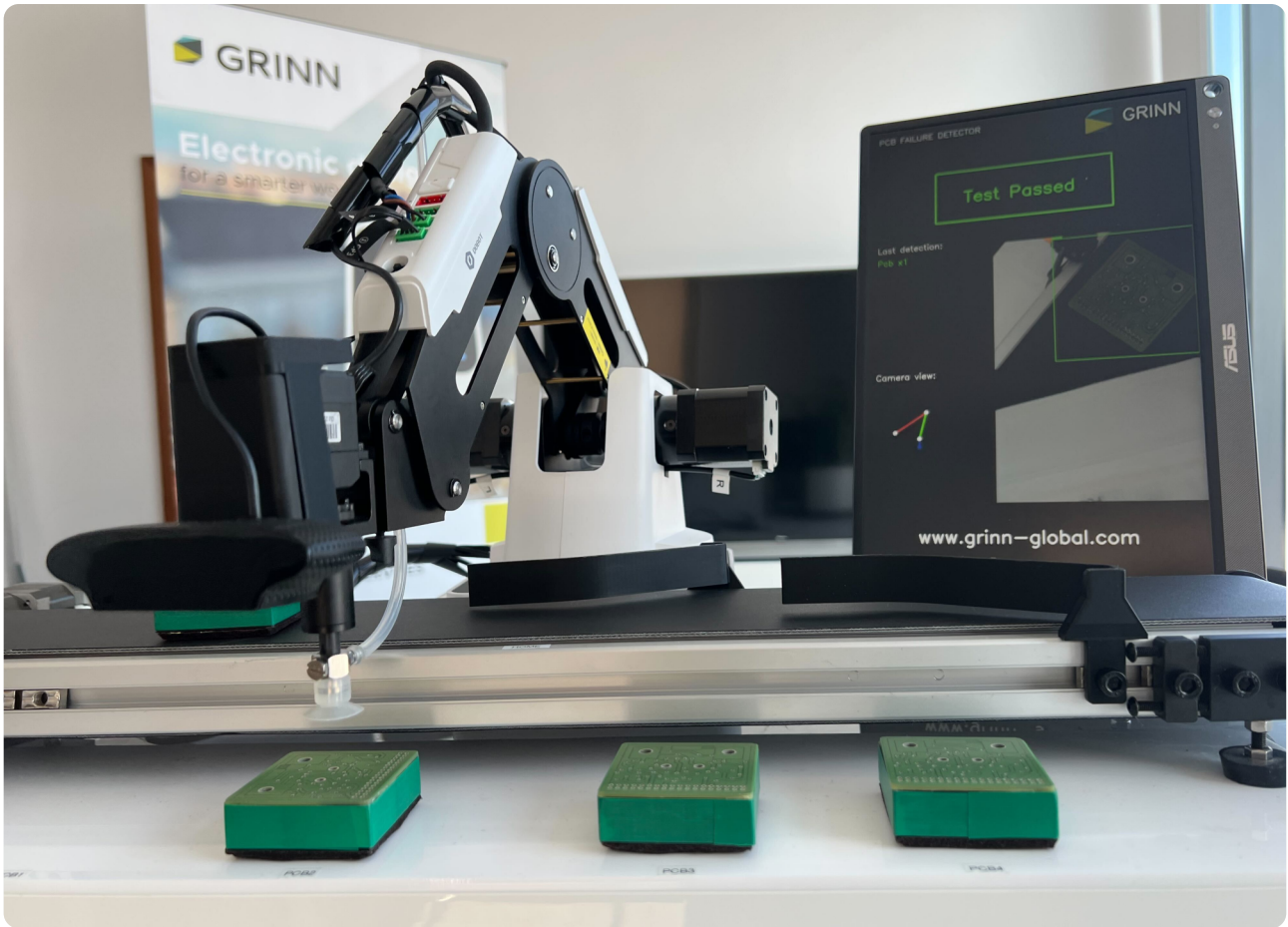


## Dynamic robot motion display

Provides vector-based motion visualization with angle tracking

## 2 | Description

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The Grinn GenioSOM-700 based PCB Failure Detection enhances quality control in PCB manufacturing by using AI-driven defect detection.

Fully integrated with robotic systems, it improves efficiency and accuracy in automated production lines. By leveraging real-time AI-powered analysis, this system detects even the most subtle defects on raw PCBs, such as trace interruptions, short circuits, and misaligned drill holes, significantly reducing production errors. The combination of high-speed processing and precision image analysis ensures that faulty PCBs are identified and addressed immediately, enhancing manufacturing reliability and minimizing material waste.

Furthermore, the GenioSOM-700's seamless integration with industrial robotics and intelligent conveyor systems allows for a fully automated inspection workflow. This level of automation not only accelerates production cycles but also reduces labor costs and human error, making it an essential tool for modern, high-efficiency PCB manufacturing environments.

## 3 | Case study

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In the pursuit of high performance, the Genio-700 distinguishes itself by providing versatile options for both CPU and NPU processing.

This adaptability allows developers to optimize their applications for maximum efficiency, whether they rely on the CPU's broad functionality or leverage the specialized AI capabilities of the NPU. This chapter illustrates a practical example harnessing the Genio-700's capabilities. The goal is to assess its performance and confirm how effectively this hardware solution meets AI-based requirements.

### 3.1 | Example application

PCB failure detection highlights the power of Edge AI in industrial automation by showcasing a robotic arm controlled by the Grinn GenioSOM-700, performing real-time PCB defect detection. The in-house trained YOLO model runs efficiently on the world's smallest Grinn GenioSOM-700, leveraging its Neural Processing Unit (NPU) to deliver ultra-low latency, high inference speeds, and power-efficient AI processing. By combining machine vision, embedded intelligence, and autonomous robotics, this solution exemplifies the next generation of AI-driven smart manufacturing at the edge.

In today's rapidly evolving manufacturing environment, the need for real-time inspection and analysis is greater than ever. Our PCB defect detection demonstration meets this demand by leveraging the powerful capabilities of the Grinn GenioSOM state-of-the-art module featuring a robust built-in NPU chip. This specialized hardware effortlessly handles complex machine vision tasks, delivering rapid and highly accurate results that drive efficiency and quality in modern production lines.

A precision-engineered robotic arm plays a pivotal role in this system, positioning and manipulating PCBs under the camera for optimal inspection. As soon as a PCB is in place, the edge AI model running on the Grinn GenioSOM-700 identifies even the smallest defects, such as solder bridging, missing components, or alignment issues. By conducting these analyses in real time, potential errors are flagged immediately, allowing for quick corrective actions and minimizing production downtime.

What sets this solution apart is its capacity to maintain ultra-low latency and consistent high throughput. The Grinn GenioSOM's NPU ensures that inference times remain exceptionally short, even when handling high-resolution images or complex neural network architectures. Meanwhile, the robotic arm integrates seamlessly with the detection process, responding swiftly to each inspection result and either marking defective boards for rework or passing them along if they meet quality standards.

By combining embedded intelligence, advanced robotics, and the power of edge computing, our PCB defect detection demonstration pushes the boundaries of smart manufacturing. This comprehensive system not only elevates quality control but also paves the way for more agile and cost-effective production processes—key advantages in today's competitive industrial landscape.

## 3.2 | System benchmarks

The Grinn GenioSOM-700-based PCB failure detection system was benchmarked using only 640x480 resolution images captured with a Logitech C920 webcam. These images are continuously processed in real-time, ensuring accurate and reliable defect identification during PCB inspection.



### **AI Inference Speed**

How quickly defects are detected in real time our AI model processes a single inference in just 22ms, ensuring rapid defect detection in real-time industrial applications.



### **Detection Accuracy**

Rate of correct defect identification, minimizing false positives/negatives using our custom AI model, we achieve a remarkable 98% accuracy in detecting PCB defects, effectively minimizing both false positives and false negatives.



### **Image Quality and Resolution**

Level of detail the AI processes for precise defect analysis for demonstration purposes, we utilize 640x480 resolution images captured using a Logitech C920 webcam, ensuring a balance between computational efficiency and sufficient detail for defect recognition.



### **Throughput**

How many PCBs per minute the system can inspect without performance loss the processing unit is capable of handling 2700 inferences per minute, allowing high-speed, continuous PCB inspection without performance degradation.



### **Seamless Integration**

Compatibility with different production lines and robotic arms the GenioSOM-700 is designed for seamless integration with various production lines and robotic systems, ensuring compatibility with automated manufacturing environments.



### **Power Efficiency & Hardware Performance**

Optimized AI inference on GenioSOM-700 in industrial conditions the GenioSOM-700 operates efficiently in industrial environments, consuming approximately 3W in our demo application, making it a power-efficient solution for AI-driven defect detection.



### **AI Adaptability**

Ability to fine-tune the model for various items, defect types, and materials leveraging "Ultralytics YOLO", our AI model is highly adaptable, allowing fine-tuning for different products, defecttypes, and material variations, ensuring versatility across diverse manufacturing applications.

## 3.3 | Benefits

Using Grinn GrinnSOM-700 offers several significant benefits for developing and deploying advanced applications, particularly in the field of computer vision and AI:



### Complete Development Framework

The Grinn GenioSOM-700 provides a comprehensive platform and optimized libraries for machine vision and deep learning applications. The system is designed to accelerate development, allowing engineers to focus on innovation rather than low-level hardware integration.



### Support for a Powerful AI Chip

Equipped with a dedicated Neural Processing Unit (NPU), the Grinn GenioSOM-700 delivers high-speed AI inference with minimal power consumption. The NPU optimizes machine learning workloads, enabling real-time processing of complex YOLO model.



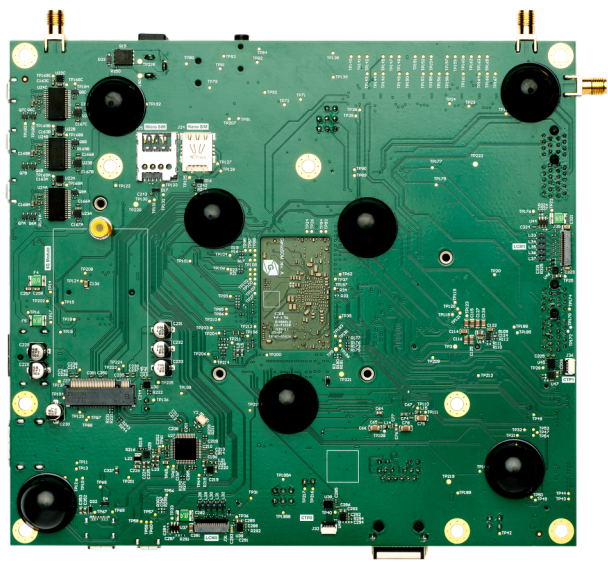
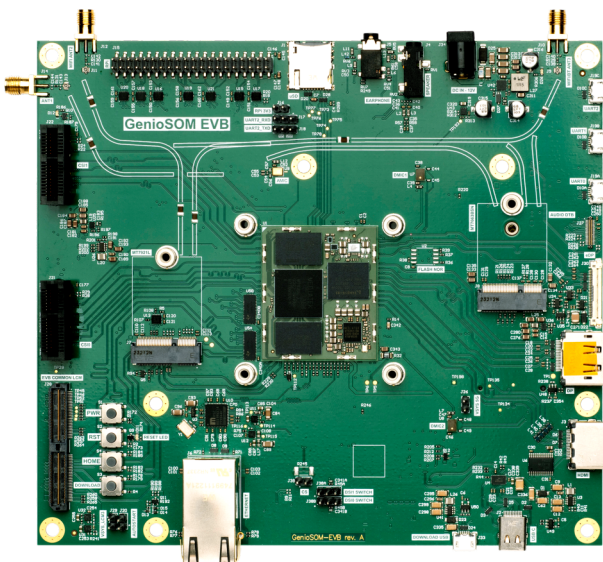
### Sufficient Hardware Resources

The Grinn GenioSOM-700 is built with a powerful Synaptics SL series processor, featuring multiple Arm Cortex-A73 cores which supports LPDDR4 RAM. It ensures smooth operation even in computationally intensive applications. The module also includes extensive connectivity options, such as Ethernet, USB, and PCIe, facilitating seamless integration into industrial systems.



### Clear Documentation

Grinn GenioSOM-700 comes with clear, well-structured documentation that guides developers through every aspect of the platform. This makes it easier to learn, develop, and troubleshoot, reducing the development time and effort required to bring projects from concept to completion.



## 4 | Value proposition

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Grinn AstraSOM-1680 combines high performance, power efficiency, application flexibility, and support for artificial intelligence and open source software. Its unique combination of a robust AI chip, low power consumption, and advanced connectivity options sets it apart from competitors. This makes Grinn AstraSOM-1680 ideal for a wide range of IoT embedded system applications where reliability, scalability, and adaptability are crucial. Whether it's for smart cities, industrial automation, or edge AI computing, Grinn AstraSOM-1680 provides a competitive set that ensures superior performance and lower total cost.

### 4.1 | Total performance

Featuring the Synaptics SL1680 processor, Grinn AstraSOM-1680 offers high computing performance with its Arm Cortex-A73 cores and GPU for 2D/3D graphics operations. The Neural Processing Unit enables to efficiently perform advanced computations such as image recognition, audio analysis and natural language processing.

### 4.2 | Power and energy efficiency

Thanks to the SL1680 processor's built-in advanced power management system, Grinn AstraSOM-1680 is extremely energy efficient. This is ideal for IoT applications where long battery life is crucial. Support for advanced power saving features help to minimize power consumption while maintaining high performance.

### 4.3 | Price

Grinn AstraSOM-1680 offers an excellent price/performance ratio, making it an attractive option for manufacturers of IoT devices and embedded systems. By combining a powerful SL1680 processor with a well-thought-out module architecture, Grinn AstraSOM-1680 enables advanced AI and IoT projects at a competitive.

### 4.4 | Availability

Grinn AstraSOM-1680 is available in a standard configuration that has been optimized for universal IoT and AI applications. The unified version of the module provides ease of integration and reduces development time, which is beneficial for manufacturers looking to bring a product to market quickly. Grinn AstraSOM-1680 is supported by a broad ecosystem of developer tools and documentation, making it easy to implement and develop applications. In addition, component supply stability and long-term product availability ensure predictability and reliability for large-scale production.

## 4.5 | Open source capability

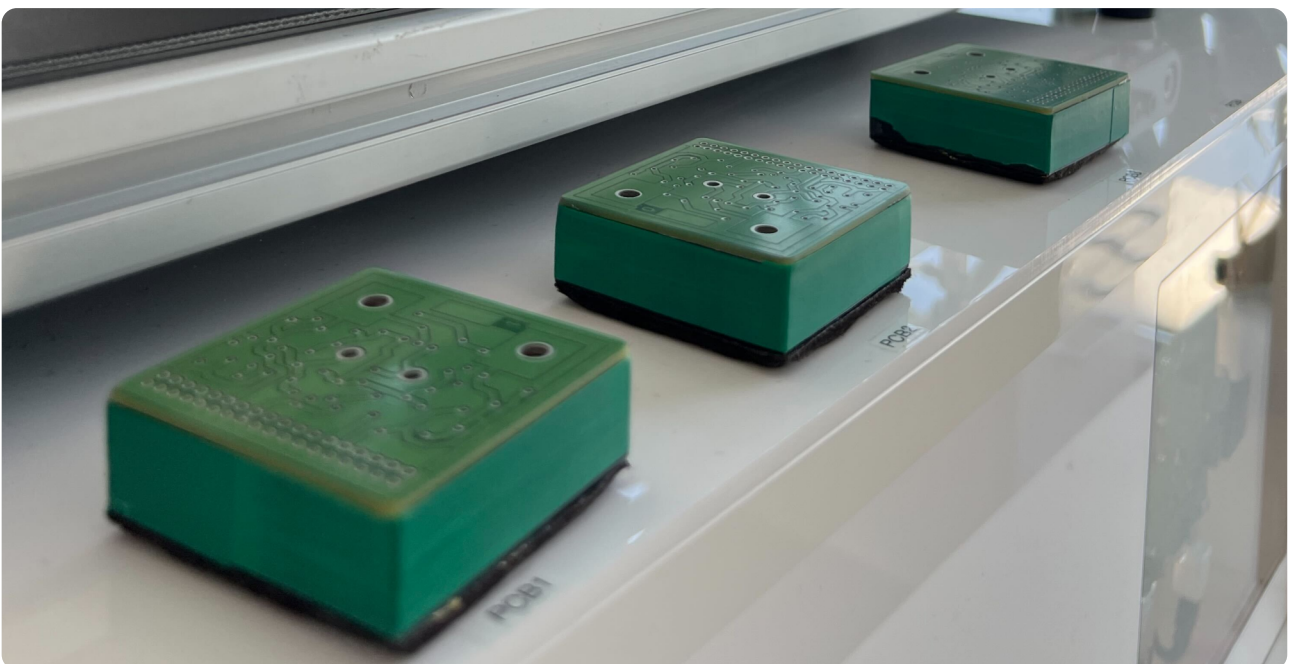
Grinn AstraSOM-1680 supports popular operating systems such as Linux and Android, enabling a wide range of open-source solutions. Its compatibility with widely used libraries and frameworks like TensorFlow Lite, PyTorch, and OpenCV provides developers with access to a vast ecosystem of tools and community support, which accelerates development cycles and enables rapid prototyping.

The flexibility of an open-source environment allows developers to customize and optimize the software stack according to specific project needs, whether for edge AI, smart cameras, or industrial IoT applications. With support for open standards, Grinn AstraSOM-1680 empowers developers to deploy and fine-tune AI and graphics-intensive applications efficiently. This open environment encourages experimentation and iterative development, leading to faster innovation cycles and quicker time-to-market for advanced IoT solutions.

Furthermore, the availability of source code provides greater control over security and updates, ensuring that the final product meets stringent compliance and security standards. The platform is well-supported by a range of open-source development tools, including cross-compilers, debuggers, and performance profiling utilities, which streamline the development process. This openness allows for extensive customization and seamless integration with CI/CD pipelines, automating testing and deployment workflows. Leveraging these advantages, Grinn AstraSOM-1680 ensures a high-quality, scalable solution that maximizes both developer productivity and the overall value proposition for IoT and AI applications.

## 4.5 | Open source capability

Using the Synaptics SL1680 processor, Grinn AstraSOM-1680 offers advanced capabilities for artificial intelligence. The built-in NPU (Neural Processing Unit) allows acceleration of machine learning and data processing operations. The module supports popular AI frameworks, making it ideal for smart devices such as smart cameras, speech recognition systems and image analysis devices.



## 5 | Contact

If you're interested in the advanced capabilities offered by the Synaptics SL1680 processor-based Grinn AstraSOM-1680 for IoT, AI, or embedded systems applications, now is the perfect time to take the next steps and accelerate the development of your project.

Grinn - a team of experts in embedded systems development and artificial intelligence - is ready to support you in integrating Grinn AstraSOM-1680 into your solutions. Working with us will allow you to realize the full potential of this platform, optimizing implementation time and minimizing project risks.



### Contact our support team

We will answer all your technical questions about Grinn AstraSOM-1680 and help you choose the optimal configuration.



### Book a dedicated technical workshop

This workshop allows you to gain a deeper understanding of Grinn AstraSOM-1680's architecture and best practices for its integration and optimization for your project requirements.



### Make an appointment for a free technical consultation

Our engineering team can arrange a demonstration session or meeting to show you the benefits of using Grinn AstraSOM-1680 in your project.



### Download technical materials and documentation

We offer detailed specifications, implementation guides and application examples to help you better understand how our technology can support your innovations.

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