

FOUR SEGMENTS – MAXIMUM PRECISION

LUMIMAX[®] LIGHTING AS KEY ASPECT OF SIEMENS INSPEKTO'S AUTONOMOUS AI INSPECTION IN VISUAL QUALITY INSPECTION

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ABSTRACT

Lighting is often an underestimated factor in industrial quality inspection. A real-world example at Siemens shows that inspection quality is not defined solely by software – it starts with image capture. In collaboration with LUMIMAX[®], the Siemens Inspekto visual inspection system was launched in early 2025: a fully integrated, AI-driven solution in which LUMIMAX[®] Smart Light technology plays a central role.

ABOUT SIEMENS INSPEKTO

Siemens Inspekto is part of the Siemens forward facing portfolio, offering smart AI-based visual inspection to manufacturers globally. The joint efforts are continuously invested in providing the most advanced tools to manufacturers so they can manage their quality needs efficiently and lead with an edge in a competitive marketplace. Siemens Inspekto simplifies complex inspection tasks and does it with a short setup process, intuitive UI removing the need for expertise in machine vision, programming or AI in order to install, commission and manage the lifecycle of their machine vision requirements



INDUSTRY

Horizontal vision solution for autonomous quality inspection; applicable in different markets such as plastic injection, metal forming, electronics, automotive, PCB assembly and more



OEM LIGHTNING

- Area Light with four independently controlled segments
- Autonomous Parameter Optimization
- Industrial-Ready Out-of-the-Box Solution



KEY APPLICATIONS

- Reflective Surfaces
- Complex Geometries
- Variable Product Mixes
- Robotic Quality Inspection
- Inline & End-of-Line Inspection

FUNCTIONALITY:

An object under inspection is illuminated from multiple directions with precisely controlled timing and intensity. Reflections are suppressed, critical features are enhanced, and the resulting image contains significantly more usable information for the inspection process.

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1 | Within the Siemens Inspekto system, AI and the segmented LUMIMAX® lighting solution work in seamless synergy. The result: consistent, high-contrast image data, even on challenging surfaces. Source: iIM GmbH

LUMIMAX® LIGHTING AS A KEY ASPECT FOR SIEMENS INSPEKTO'S AUTONOMOUS AI INSPECTION IN VISUAL QUALITY INSPECTION

Suhl, June 2026. Manual visual inspections are error-prone, time-consuming, and difficult to scale. At the same time, visual inspection systems represent one of the most demanding disciplines in industrial automation. Different materials, surface properties, geometries, and production environments place high demands on camera technology, algorithms and overall system design.

Artificial intelligence is already fundamentally changing industrial quality inspection. Within the Siemens Inspekto solution, visual inspection performance is achieved through the coordinated interaction of all system elements, leveraging the power of advanced AI models together with precisely controlled illumination.

When Light Makes the Difference

Lighting remains one of the most underestimated factors in machine vision. Image quality is determined at the point of image formation, where optical conditions directly influence the information available to the AI. Reliable inspection therefore depends on the coordinated interaction between software, camera, and illumination. With the visual inspection system Siemens Inspekto, this interaction has been consistently rethought. Designed as an autonomous AI-based inspection system, Siemens Inspekto enables users to install, operate, and adapt visual inspections throughout the entire lifecycle without machine vision expertise. The system is already successfully

deployed in multiple Siemens plants for industrial quality inspection, as well as customers worldwide. A key element of this approach is the LUMIMAX® Smart Light, a lighting solution developed in close partnership with Siemens specifically for Inspekto. Rather than serving as a standalone illumination device, it is engineered as a functional component of the system infrastructure, using software-driven, independently controllable segments to deliver sequenced illumination (timing and intensity) with no manual parameter setup required.

From Plastics to Metals: One System & one Light for diverse Applications

Siemens Inspekto was deliberately designed as a horizontal solution for a wide range of industries, from plastics and metal processing to electronics, automotive manufacturing, and printed circuit board assembly. The objective is to create a system that remains easy to use while adapting flexibly to changing production conditions. This flexibility places specific demands on illumination. Different inspection objects respond very differently to light: transparent plastics, highly reflective metal surfaces, or finely structured components each require distinct illumination characteristics. Conventional lighting solutions are often too static for such variability, as they rely on manual adjustment or expert-level configuration. To support autonomous inspection, illumination must therefore be as flexible and adaptive as the AI itself.



2 | The LUMIMAX® Smart Light, the camera and the AI work as a closed system. The AI independently selects all optical parameters for the corresponding scenario. Source: Siemens

Thinking Along: Segmented Illumination designed for Autonomous AI

“We needed a lighting solution with a specific, unique layout to allow us to control different aspects of the light in a very accurate method,” explains Noam Horovitz, Lead Product Portfolio Manager at Siemens Inspekto. “Only in this way we were able to generate lighting sequences that work precisely with our AI algorithms. Each sequence activates different functions with precise timing, fully automatic and without any user intervention.”

This clearly defined the joint development direction with LUMIMAX® by Exaktera. The goal was not simply a lighting solution with maximum light output, but controlled, reproducible illumination that actively supports image formation as part of the AI-driven inspection process.

Development Expertise Turning Requirements into Architecture

At this point, the joint development work with LUMIMAX® began. Not with mechanical form factors or lumen values, but with the system-level requirements of autonomous AI inspection:

- What degrees of freedom are required to support self-adaptive inspection?
- How must light be controlled to ensure stable and reproducible algorithm performance?
- How can this complexity be resolved for the user?

These requirements were consistently translated into application-specific lighting architecture. Optics, electronics, mechanics, and controller technology were developed together from the outset, not as an add on, but as an integral part of the overall system. The result is a purpose-built lighting solution precisely aligned with Siemens Inspekto's autonomous AI inspection concept and its industrial deployment.

“For me, this project demonstrates how clearly defined system requirements can lead to a technologically new and robust solution,” says Linda Müller, Senior Product Technology Manager at LUMIMAX®,



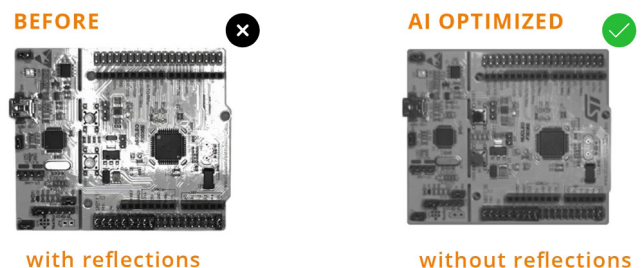
3 | The tailor-made solution with 4 segments developed by LUMIMAX® is an integral part of the system intelligence. Source: LUMIMAX®

“In autonomous inspection, image quality is fundamental. Within this system, lighting is no longer a passive accessory, but an actively controlled component within the inspection process, contributing directly to reproducible AI-based decisions. Delivering this level of integration within a tight timeline was made possible by LUMIMAX®'s long-standing experience in machine vision lighting and by the close, collaborative partnership with the Siemens team.”

Four Segments, One Mission: Managing Reflections

A central feature of the LUMIMAX® Smart Light is its segmented design. The area illumination is divided into four independently controllable segments, enabling illumination from different directions, with precisely defined intensity and timing sequences. Controlled by Siemens Inspekto proprietary software, these segments enable advanced illumination strategies tailored to the inspection task.

This design forms the basis for Siemens' Anti-Reflection Imaging Mode, which selectively suppresses disturbing reflections on highly glossy or reflective surfaces while relevant features remain visible.



4 | Imaging with Siemens Inspekto using the example of a printed circuit board assembly. The AI-optimized image of a printed circuit board clearly without reflections. Source: Siemens

The result is a clearly defined, high contrast image, even under challenging conditions. In practice, the entire system reduces commissioning effort during setup, improves repeatability, and ensures stable inspection results across varying products and environments. The combination of Anti-Reflection Imaging and Siemens Inspekto AI enables the generation of inspection images that are specifically tailored to autonomous evaluation across a wide range of conditions.

Autonomy Instead of Parameterization

The system, using Siemens Inpekto proprietary AI model, automatically adapts the lighting to the respective inspection object. Lighting modes are activated, combined, or switched via software, without mechanical intervention or user interaction. The system controls the camera, the lighting, and AI as a closed, autonomous system.

Exposure times, PWM frequencies, or illumination angles are selected independently by Siemens Inpekto AI engines for each use case and continuously readjusted throughout the entire inspected product lifecycle. This enables consistent image quality even as products, materials, or environmental conditions change.

Industrial Readiness by Design

In addition to its functional role, the LUMIMAX® Smart Light meets the requirements of industrial production environments. It operates flicker-free to avoid disturbing personnel near the line. It supports for high Ingress protection, and integrates seamlessly into industrial communication infrastructures. The result is a lighting solution that not only meets industrial requirements but also integrates seamlessly into real production environments. Delivered as part of the Siemens Inpekto system the user receives an out-of-the-box product, including dedicated hardware and proprietary software on a SIMATIC IPC, a ready to use solution.

Siemens Inpekto is fully integrated with the TIA Portal, allowing for efficient PLC integration with Siemens controllers using Profinet and can be seamlessly incorporated into automation projects and production lines. The system offers flexible deployment options, supporting the inspection of parts on production lines or handled by robots, and includes additional industrial connectivity protocols such as Ethernet/IP and TCP/IP.

Partnership as a Success Factor

The requirements for machine vision systems today are as diverse as the industries and applications in which they are used. Meeting



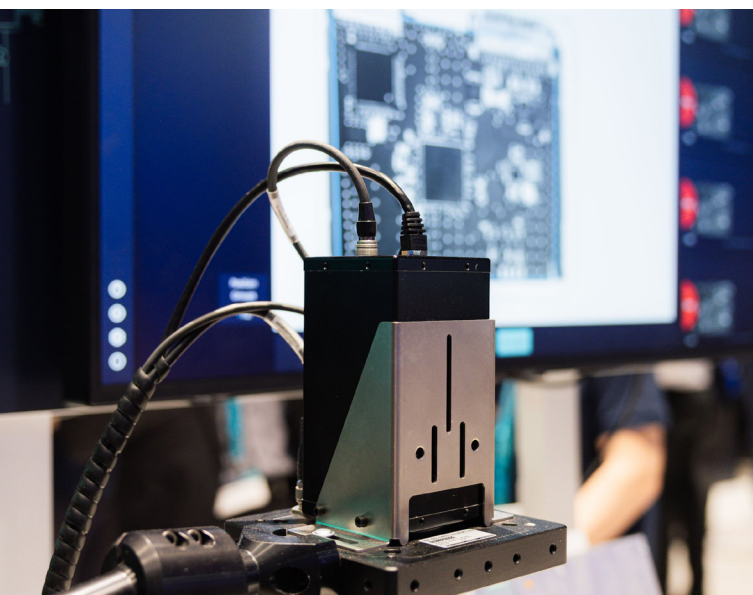
6 | Siemens Inpekto system featuring the LUMIMAX® smart light can be integrated into real production environments, whether inline, offline or end of line. Source: Siemens

these requirements often takes more than modifying individual components. It requires system-level engineering focused on application performance and customer-centric approach, directly addressing their need for greater efficiency, reliability, and a sustained competitive edge.

The collaboration between Siemens and LUMIMAX® demonstrates how modern OEM development is realized: through close cooperation, system-level thinking, and a shared focus on autonomous inspection performance. The LUMIMAX® Smart Light is not an off-the-shelf component, but a lighting solution engineered in partnership as an integral part of Siemens Inpekto's autonomous AI inspection solution. The resulting system demonstrates that inspection performance does not arise from individual components, but from their deliberate integration into a coherent, autonomous imaging system. ■

About iIM GmbH and LUMIMAX®

iIM GmbH – part of Union Park's holding company Exaktera – is developer, manufacturer and distributor of high-quality, high-performance products for industrial image processing. Based in Suhl, Germany, we develop and manufacture high-performance and highly functional LED illumination under the LUMIMAX® brand for Machine Vision applications in a very wide range of industrial sectors, including automotive, semiconductor, pharma, and the food and beverage industry. A further department develops and markets special measuring technology and peripherals for the cable and wire industry to record geometric features, particularly on insulating covers and cable sheathing, in accordance with standards. A team of over 80 engineers, technicians and skilled workers assists our customers as a partner when realising their challenges. Certified in accordance with Global Certificate ISO 9001:2015 by DEKRA, iIM GmbH guarantees quality at the highest level.



5 | Distracting reflections on high-gloss or reflective surfaces are specifically suppressed, while relevant features remain visible. This creates a clearly defined, high-contrast image for the AI – even under difficult conditions. © Giulia Iannicelli for Siemens 2025

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