

White Paper: Engineering Intelligence in Factory Automation Systems

Critical Considerations for Embedded Systems, HMIs, and Smart Manufacturing Integration

Date: May 2026

Table of Contents

- 1. Executive Summary**
The convergence of automation, data intelligence, and industrial resilience.
- 2. The Factory Environment: Defining Automation-Grade Reliability**
Continuous operation, harsh conditions, and precision control.
- 3. High-Performance HMIs for Machine Control**
Visibility, usability, and durability on the production line.
- 4. The Intelligent Core: Embedded Automation Architecture**
Real-time processing for robotics and process control.
- 5. Connectivity & Analytics: The Smart Factory Framework**
IoT, AI, and predictive manufacturing systems.
- 6. Signal Integrity and Industrial Interconnects**
Reliable communication in electrically noisy environments.
- 7. Lifecycle Management: Concept to Scaled Deployment**
From prototyping to long-term production support.
- 8. Compliance, Standards, and Operational Safety**
Ensuring reliability and quality in automated environments.
- 9. Conclusion: The Future of Factory Automation**
Enabling intelligent, connected, and adaptive manufacturing systems.

1. Executive Summary

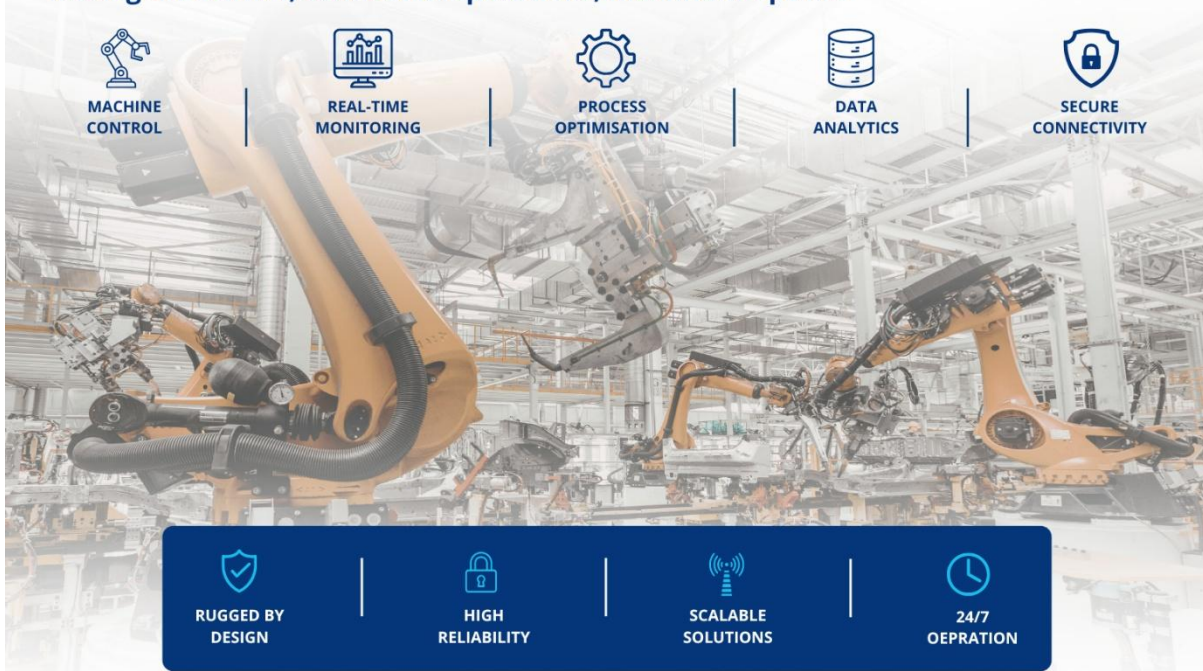
Factory automation is at the heart of modern manufacturing transformation. As production environments evolve toward smart factories, systems are becoming increasingly interconnected, data-driven, and autonomous.

From robotic control systems and production line monitoring to AI-driven quality inspection, factory automation relies on a tightly integrated hardware ecosystem. This includes high-performance embedded computing, robust human-machine interfaces (HMIs), and secure connectivity frameworks.

This paper explores the engineering principles required to deliver reliable, scalable, and intelligent factory automation systems, enabling manufacturers to increase productivity, reduce downtime, and optimise operational efficiency.

Factory Automation System Architecture

Intelligent control, connected operations, maximum uptime



2. The Factory Environment: Defining Automation-Grade Reliability

Factory automation systems operate in demanding environments where reliability directly impacts productivity and profitability.

Key environmental and operational challenges include:

- **Continuous Operation:** Systems often run 24/7, making uptime critical

- **Thermal and Mechanical Stress:** Exposure to temperature variation, vibration, and shock from machinery
- **Dust and Contaminants:** Industrial environments require sealed, durable systems
- **Precision Requirements:** Automation systems must deliver consistent, repeatable performance

Industrial displays and embedded systems are specifically engineered to withstand harsh conditions such as vibration, dust, temperature fluctuations, and continuous use.

Reliability in factory automation is not optional – it is foundational to operational success.

3. High-Performance HMIs for Machine Control

HMIs are central to factory automation, enabling operators to monitor, control, and optimise production processes.

Clarity and Visibility

Operators rely on displays for real-time information:

- High-brightness displays (up to ~3,000 nits) for clear visibility in factory lighting
- Optical bonding to reduce reflections and improve durability
- Appropriate screen sizing based on viewing distance and complexity of data

Responsive Interaction

Modern factory HMIs must deliver intuitive and reliable control:

- PCAP touch technology for fast, accurate input
- Glove-compatible operation for industrial users
- Wet-touch capability for challenging environments

Ruggedisation

Factory HMIs are built for durability:

- IP65/IP68-rated enclosures for dust and water protection
- Impact-resistant designs for high-use environments
- Long lifecycle components aligned with industrial systems

These systems enable operators to monitor machine status, adjust parameters, and respond to alarms in real time.

4. The Intelligent Core: Embedded Automation Architecture

Embedded systems act as the control layer of factory automation, enabling real-time operation of machinery and production lines.

Feature	Technical Specification
Processing Power	ARM, Intel, or AMD platforms for real-time control and robotics
Form Factors	SBCs, Box PCs, and integrated control systems
Ruggedisation	Fanless, shock- and vibration-resistant designs
Longevity	10–15 year lifecycle support


Key design priorities:

- **Real-Time Processing:** Deterministic performance for machine control and robotics
- **System Integration:** Seamless communication with sensors, actuators, and PLCs
- **Compact Design:** Integration into robotic arms, control cabinets, and machinery


Embedded systems combine processing, display, and input technologies into dedicated control platforms tailored to specific industrial tasks.

Embedded Automation Computing

Powerful performance. Built for the shop floor.




HIGH PERFORMANCE
Intel, AMD, ARM processing



FANLESS DESIGN
No moving parts, higher reliability



COMPACT FORM FACTOR
Space saving integration



LONG LIFE-CYCLE
10 - 15+ year availability

5. Connectivity & Analytics: The Smart Factory Framework

Factory automation is driven by connectivity and data intelligence.

- **Industrial IoT (IIoT):** Real-time monitoring of machines, production lines, and environmental conditions
- **Edge Computing:** Local processing for immediate decision-making and reduced latency
- **AI Driven Analytics:** Predictive maintenance, quality control, and process optimisation
- **Edge-to-Cloud Integration:** Combining local control with centralised analytics

Smart factory systems enable manufacturers to shift from reactive to proactive operations, reducing downtime and improving efficiency.

6. Signal Integrity and Industrial Interconnects

Reliable communication is critical in factory automation systems.

- **EMI Shielding:** Protecting signals in electrically noisy environments
- **Rugged Cabling:** High-flex, IP-rated assemblies for continuous operation
- **Protocol Support:** Reliable communication across industrial networks

Signal integrity ensures accurate data transmission between sectors, controllers, and HMIs, maintaining system stability and performance.

Built for Industrial Environments



TEMPERATURE RESISTANT
-20°C to +70°C operation



VIBRATION & SHOCK RESISTANT
MIL-STD compliant



DUST & WATER PROTECTION
IP65 / IP66 front protection



EMI / EMC
Protection



24/7 RELIABILITY
Designed for continuous industrial use



7. Lifecycle Management: Concept to Scaled Deployment

Factory automation systems require long-term planning and scalability.

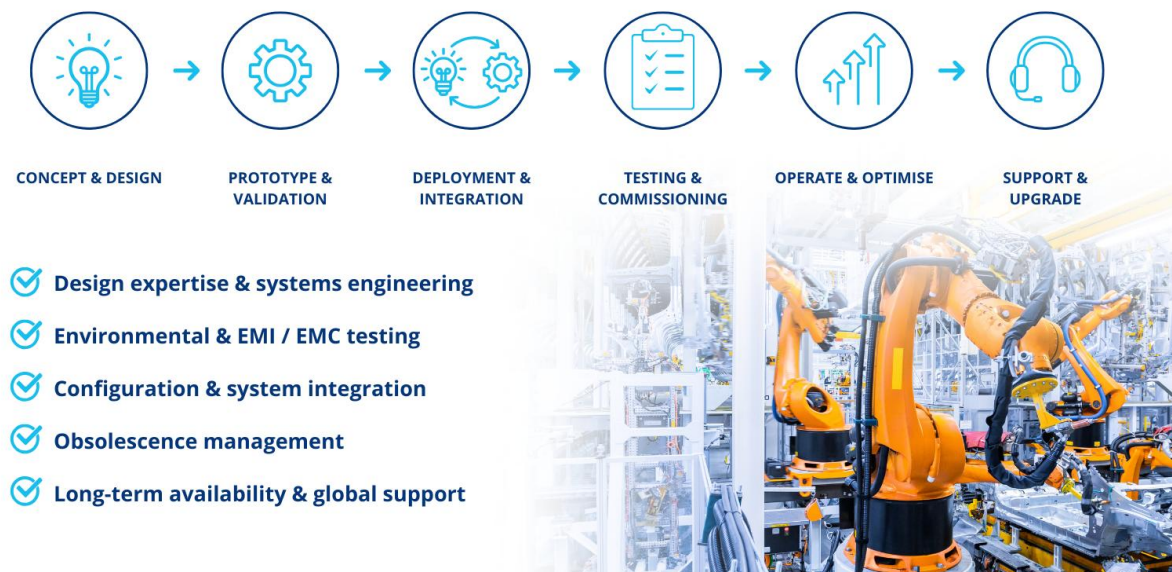
1. **Concept & Design:** Custom engineering for specific automation requirements

2. **Prototyping:** Rapid validation of system performance and integration
3. **Testing:** Environmental, mechanical, and EMI validation
4. **Deployment:** Integration into production lines with minimal disruption
5. **Lifecycle Support:** Obsolescence management and long-term availability

End-to-end engineering ensures systems remain reliable throughout their operational lifecycle.

Life-Cycle Support

From concept to long-term support.



8. Compliance, Standards, and Operational Safety

Factory automation systems must meet stringent standards to ensure safety and reliability:

- **CE / FCC Compliance:** Regulatory requirements for industrial equipment
- **ISO 9001:** Quality management systems
- **EN50155 (where applicable):** Shock and vibration standards for industrial environments
- **Functional Safety Considerations:** Ensuring safe machine operation

Compliance is essential to ensuring both operational safety and market readiness.

Compliance & Quality

Built to meet global standards



QUALITY
MANAGEMENT



EUROPEAN
CONFORMITY



CERTIFIED
COMPONENTS



COMPLIANT



EN 61000-6-2
EMC IMMUNITY

9. Conclusion: The Future of Factory Automation

The factory of the future is intelligent, connected and highly adaptive. Automation systems are evolving from isolated machines into integrated ecosystems powered by data and real-time intelligence.

By combining:

- High-performance HMIs
- Robust embedded computing
- Intelligent connectivity and analytics

Manufacturers can achieve:

- Increased productivity
- Reduced downtime
- Enhanced operational flexibility

The future of factory automation depends on integrated, resilient engineering solutions that enable smart manufacturing at scale.

Review Display Systems: A Volex Group Company

As part of the Volex Group, Review Display Systems provides advanced technology solutions for factory automation, combining displays, embedded systems, IoT platforms, and interconnect technologies.

With expertise in smart factories, robotics, and industrial automation, RDS delivers tailored solutions designed to withstand harsh environments while enabling intelligent, data-driven manufacturing.

Through a vertically integrated approach, from concept and prototyping to high-volume production, RDS supports customers in building reliable, scalable, and future-ready automation systems.