

# Verification and Traceability in Automotive Assembly

Backstopping Safety and Reliability with Engineered Fasteners.



## Introduction

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As vehicle systems become increasingly complex, the need for robust verification and traceability in automotive assembly has grown commensurately. Beyond the obvious critical safety implications, verification and traceability are essential to ensuring customer satisfaction and helping to maintain compliance with evolving regulatory standards.

For automotive engineers, the challenge is clear: ensure that critical fasteners and system components are installed accurately and can be traced throughout the vehicle's lifecycle. As technologies such as Advanced Driver Assistance Systems (ADAS) and infotainment systems expand in capability, and new technologies like drive-by-wire are introduced, the margin for assembly error has never been smaller.



## The Implications of Assembly Failure

Assembly failures can lead to significant consequences for automakers, and worse, for their customers. These failures can compromise vehicle safety, lead to expensive recalls, and damage brand reputation.

## Case Studies in Assembly Failure

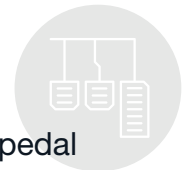
### Wire Harness Defects in Major Automakers

In recent years, several major manufacturers have recalled hundreds of thousands of vehicles due to defects in wire harness assemblies. In some cases, poorly routed harnesses caused short circuits, fire risks, and failures in critical systems like airbags and steering. These defects underscore the importance of traceability to ensure proper routing and attachment of wiring during assembly.



### Accelerator Pedal Detachment

A major manufacturer recall was required after discovering that accelerator pedal covers could become detached from their mountings during use. This fastening strategy failure created a serious safety risk and highlights the need for reliable fastening and verification in an application that affects both customer experience and safety.



### Rear Axle Hub Bolt Failure

A major automaker recalled more than 113,000 trucks due to rear axle hub bolt failures, which risked the axle detaching from the vehicle. Improper fastening during assembly was identified as the root cause, leading to significant safety risks and costly repairs. This case highlights the critical role of traceability in fastener installation.



These examples highlight the need for robust traceability to prevent such failures, minimize recalls, and protect both brand equity and customer safety.

## Poka-Yoke, Verification, and Traceability

While Poka-Yoke, verification, and traceability techniques are related, each plays a distinct role in the assembly process:

### Poka-Yoke

Product design and fixturing can be used to prevent assembly errors by ensuring parts fit only where they are intended. Poka-Yoke techniques can be applied to ensure correct match, position, or orientation of components but do not confirm that assemblies have been verified or are traceable. For assemblies with critical functionality, additional verification and traceability steps are required—either during the direct assembly or at a downstream station—to ensure the process has been accurately completed.



### Verification

Verification confirms that each component is installed correctly at the time of assembly. Conventional fastening methods typically rely on tactile or audible feedback to confirm correct installation for clipped parts or torque and angle measurement for threaded fasteners, which confirm that fasteners have been tightened to meet specific installation criteria. While verification is valuable, it does not create a permanent record linking components to the assembly process unless the data is captured.



### Traceability

Traceability goes beyond immediate verification by ensuring assembly data is recorded and accessible throughout the vehicle's lifecycle. This capability is essential not only for meeting regulatory compliance standards but also for effective quality troubleshooting and recall management.



## Beyond Safety: Traceability's Role in Preventing Recalls & Enhancing Customer Experience

Traceability isn't just critical for safety systems—it plays a pivotal role in maintaining quality and minimizing warranty costs across a range of vehicle systems. ITW Automotive has identified several areas where traceability can have a major impact:



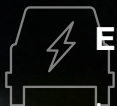
### Infotainment Systems

As vehicles become more connected, ensuring that wiring and sensors in infotainment systems are correctly installed is essential. Traceability can help automakers avoid the costly recalls associated with faulty electronics or software updates that result from improper assembly.



### ADAS & Sensor Systems

Sensors play a key role in enabling features like automatic braking, lane-keeping assistance, and 360-degree camera systems. Ensuring that these sensors are correctly fastened and traced back to their installation data is critical for ensuring reliable performance over time.



### Electrical Systems

Increasingly sophisticated wiring systems that control everything from lighting to in-car connectivity can fail if installed incorrectly. Traceability helps engineers identify where errors occurred in assembly and address them before they lead to costly repairs or customer dissatisfaction.

By expanding traceability beyond safety-critical components to cover consumer-interactive technologies, automakers can not only reduce the risk of recalls but also enhance the overall customer experience, leading to higher satisfaction and lower warranty costs.

## Regulatory Considerations and the Increasing Importance of Traceability

Traceability is playing an ever-greater role in compliance with safety regulations across key global markets, including North America, Europe, and China. International quality management automotive standards such as IATF 16949 also demand robust processes for key safety components, ensuring that any faults can be tracked and addressed.

As automotive systems become more automated and interconnected, ensuring regulatory compliance will require new methods of verification and traceability. ITW's innovative solutions help manufacturers stay ahead of evolving regulations by providing real-time data on assembly accuracy.

## Current Trends & Challenges in Traceability and Verification

The automotive industry has traditionally relied on approaches like torque and angle measurement as a standard for verifying bolt and fastener installations. While this method remains effective, it presents challenges, including:

### **Space Constraints**

The physical space needed for torque drivers and weld nuts can be limited, especially in compact vehicle designs.

### **Capital Investment**

Torque-based systems often require expensive equipment, adding to the costs of assembly.

### **Cycle Time**

Bolt installation can slow down assembly lines, adding seconds per vehicle that impact production efficiency.

### **Electrical Insulation**

Short circuits could occur between torque drivers or metal screws during assembly to EV components.

### **Ergonomics and Damage Risks**

Operators using torque drivers in tight spaces may inadvertently cause vehicle damage, such as scratching paint.

# ITW Automotive's Innovative Current Solutions

## Barcode Systems

ITW's fastener technology uses barcodes that are unreadable until the fastener is fully installed. Once correctly installed, the barcode becomes readable, enabling both immediate verification and long-term traceability. This innovative approach eliminates the need for traditional torque-based systems, reducing capital and equipment costs, speeding up the assembly process, and minimizing the risk of vehicle damage during installation.

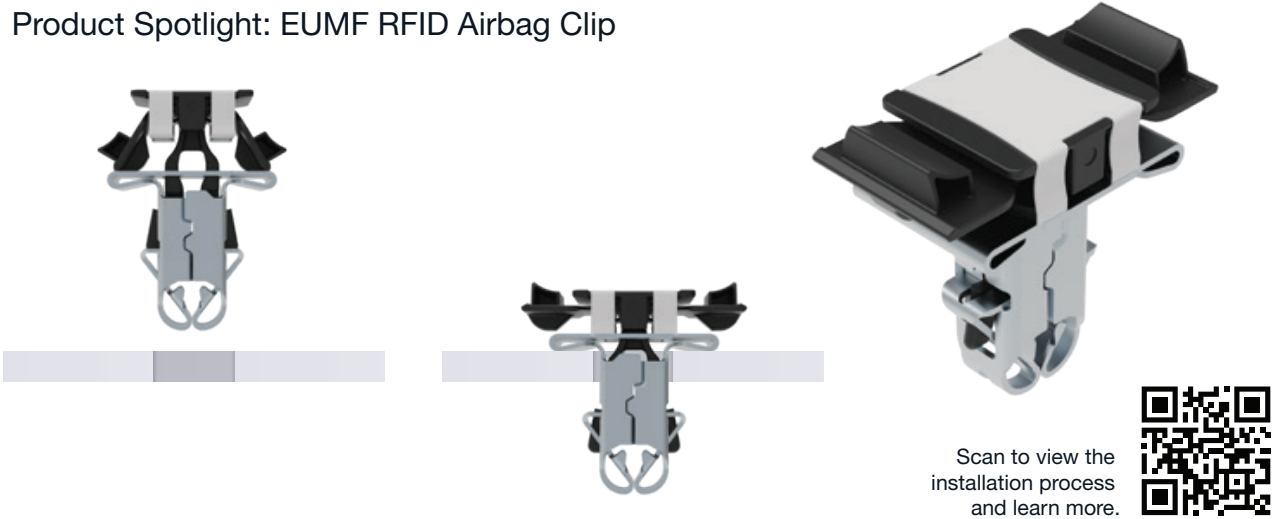
### Product Spotlight: Traceable Routing Clip



## RFID Systems

ITW also provides RFID-enabled solutions. These systems feature antennas that remain disconnected until the fastener is fully installed, ensuring proper assembly without requiring additional actions from assembly operators. The RFID system can signal correct installations remotely, eliminating the need for direct line-of-sight verification. This approach reduces labor time, reduces space requirements on the assembly line, and minimizes the need for expensive, bespoke vision systems.

### Product Spotlight: EUMF RFID Airbag Clip



## ITW's Vision for the Future of Traceability

While ITW believes barcode and RFID solutions are among the most versatile and practical traceability technologies available today, we continue to pioneer advancements that enhance verification and traceability for our customers. Our R&D efforts focus on the following next-generation solutions:

### **Sensor-Embedded Fasteners**

Designed to provide real-time data on installation accuracy, reducing the reliance on manual verification and ensuring precision.

### **Sensor-Monitored Assembly for Clipped Fasteners**

Systems that use sensors near the assembly operation or wearable devices to monitor sound, vibration, or pressure during clipping operations. AI software analyzes these signals to confirm proper installation, offering a fully traceable process.

### **Digital Twin Traceability**

Leveraging marking systems (e.g. QR codes) applied to fasteners early in the manufacturing process, a digital twin is created for each component. This enables advanced process control, quality improvements, and lifecycle traceability.





## Recommendations for Automotive Engineers

### **Consider Risks:**

Safety-impact assembly failures shouldn't be the only applications considered. Any high-risk area impacting quality or customer experience may warrant a traceable fastening solution.

### **Integrate Traceability Early:**

Include traceability considerations during product design and assembly line development to minimize warranty risks.

### **Embrace Data-Driven Traceability:**

Use barcode, RFID, and sensor technologies to ensure reliable quality control and regulatory compliance.

### **Collaborate with Suppliers:**

Work with experienced suppliers to develop optimal assembly, verification, and traceability solutions.

## Conclusion

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As vehicle complexity continues to grow, the need for robust traceability and verification systems will only increase. ITW's innovative fastener solutions are customized to provide the precision and reliability required to meet these challenges, ensuring that automotive engineers can confidently verify and trace the installation of key components and systems.



We believe innovation begins  
with collaboration and trust.

# Let's work together.

ITW Automotive is active in 15 countries  
around the world. Our local expertise centers  
let us work closely with customers and  
provide them with the solutions they need.

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