Unit-Level Traceability for Automotive Customers

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Automotive product traceability has existed in one form or another for several decades. Traceability generally refers to tracking and tracing each component that comprises every sub-system in a car. Traditionally, this has been achieved with direct part marking on mechanical or electronic components, using 1D or 2D barcodes or radio-frequency identification (RFID). Since vehicle recalls are costly, this process was originated to capture the origins of critical components. Recently, manufacturing traceability has evolved from a defensive mindset of ‘minimizing recalls’ to a proactive posture of ‘compliance.’ As compliance mandates increase, so do the associated fines for non-compliance. The Federal Transportation, Recall Enhancement, Accountability and Documentation (TREAD) Act requires vehicle manufacturers to report to the National Highway Traffic Safety Administration (NHTSA) any excursions on the reliability of the components. As a result, manufacturers rely on traceability to keep abreast of gaps in the value chain to meet end user safety requirements.

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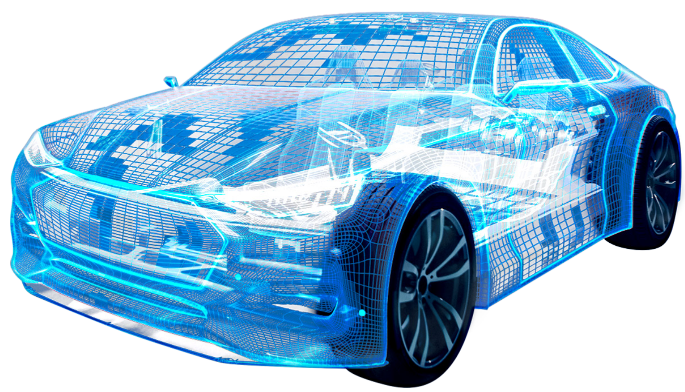
Semiconductor content in vehicles is on the rise making traceability of these components increasingly important. While there’s no specific traceability standard for semiconductor integrated circuits (ICs), relevant work has been done by various stakeholders in the automotive semiconductor supply chain. For example, the Single Device Traceability Task Force that emerged from the SEMI Collaborative Alliance for Semiconductor Test (CAST) has identified the need for device traceability through the supply chain [1]. This includes not just the traceability of devices but also semiconductor die, lead frames, epoxy, bond wires and printed circuit boards.



Two key automotive application segments, advanced driver-assistance systems (ADAS) and electrification, are expected to undergo significant innovation enabling autonomous electric vehicle (AEV) programs at various automotive OEMs. Several mission-critical safety systems are part of these efforts, including electronic stability control, lane departure warning, anti-lock brakes, adaptive cruise control and traction control that can reduce the number of traffic accidents. All of these systems require complex electronic components such as high-speed processors, memory, controllers and sensors to ensure the reliability and safety of a vehicle.

However, considering the complexities of the modern age semiconductor supply chain, including fabless design houses, foundries, integrated device manufacturers and outsourced assembly and test (OSAT) suppliers, there is renewed emphasis on unit-level traceability (ULT). As an OSAT partner to automotive IC suppliers, Amkor offers ULT as an added benefit to our automotive assembly and test services. The motivation for traceability from automotive OEMs arises from either warranty (field failures) concerns or pre-delivery (0 km or 0 hr) failures. According to one warranty report [2], annually $40 billion was paid in claims by the car companies over the last 5 years. Further, estimates from a leading European OEM suggests that for every

$1 of warranty costs, nearly 4 cents can be attributed to the failures of semiconductors. While the financial impact is clear, recalls also result in reputation loss to OEMs as well as component suppliers and puts significant stress on supply chain management.

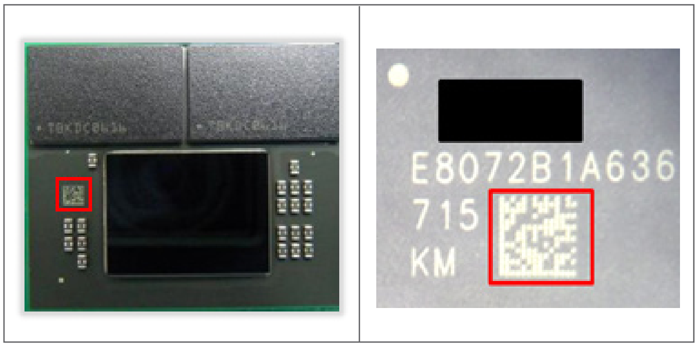


Figure 1. Examples of Packages with 2D Barcodes for ULT

In the aftermath of a warranty problem, the chip supplier embarks on an eight disciplines (8D) problem solving effort to find the root cause and devise a short-term fix and a long-term solution. Generally, OEMs require an 8D report in less than 10 days, especially if the failures are safety related. If the failure is related to a semiconductor component, ULT can help quickly pinpoint origins of the failed components. For ULT to be effective, manual processes must be replaced with automated ones, capturing, storing and managing information automatically. While there is huge demand for traceability, the biggest challenge remains in identifying the protocols for manufacturing data across the supply chain. Formatting such diverse data sets and subsequent communication to all stakeholders is challenging.

ULT provides information from an assembled IC using a 2D barcode marked on top of the device as shown in Figure 1. The data includes information such as wafer identification, die position, substrate or leadframe information and equipment used in the process. A modified assembly process flow may include additional 2D laser mark on the leadframe, automated optical inspection (AOI) and open-short testing for robust control. In this approach, 100% manual optical inspection has been replaced with AOI. As the package moves along the assembly, a 2D barcode reader verifies whether the strips are in the correct lot and based on processing information from each step, final 2D barcodes are laser marked on top of the package. ULT services include not just data collection of processes, materials and equipment history but also real-time retrieval and transmission.

For automotive customers, the ULT data retention is at least 15 years compared to 5 years for commercial customers. Further, the benefits of ULT are not just limited to providing traceability in manufacturing operations but also in shortening product development cycles. Data such as strip map, wafer map, bill of materials and the resulting assembly and test yields, can be used to shorten engineering data turns via data analytics. Such an ULT system ensures that the product meets 'zero defect' quality standards while providing real-time access to the manufacturing information with ultimate goals of increased customer satisfaction and meeting compliance mandates.

References

[1] https://blog.semi.org/technology-trends/device-traceability-and-semis-single-device-tracking-initiatives

[2] https://www.warrantyweek.com/archive/ww20180816.html

About the Author

Ajay Sattu joined Amkor in 2018 and is currently a member of the Automotive marketing team, with focus on electrification, reliability and product strategy. Prior to joining Amkor, he worked for International Rectifier (Infineon), managing technology and product development of wide bandgap semiconductors. Ajay has published more than ten articles and presented at several conferences in the emerging technologies area of GaN and SiC. He holds a Ph. D in Electrical Engineering from University of South Carolina and an MBA from UCLA Anderson.