Managing ISO 26262 Compliance with Seapine Software
Abstract

Carmakers, their suppliers, and developers of automotive components can quickly and cost-effectively prove compliance with the ISO 26262 standard through the use of an integrated product development management solution.

Seapine’s integrated product development management solutions, which include TestTrack and Surround SCM, offer significant productivity and cost benefits for companies seeking to comply with the ISO 26262 standard. Together, TestTrack and Surround SCM make compliance verification easier, less error prone, and more cost effective by automating the creation, management, maintenance, and documentation of requirements traceability.

This guide discusses how Seapine Software’s product development management solutions help companies prove compliance with ISO 26262.
New Challenges in Functional Safety

A Chevy Volt requires five times more software code to operate than an F-22 Raptor. The Mercedes S-Class takes over 100 million lines of code—50 times more code than the fighter jet.

The explosion of embedded software has had an immense impact on the automotive industry, especially in the area of functional safety. As you can see in Table 1, modern luxury cars top the list for requiring the most code.

<table>
<thead>
<tr>
<th>LINES OF CODE</th>
<th>SYSTEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>100,000 to 999,999</td>
<td>iPhone apps, older (80s) versions of software like Photoshop</td>
</tr>
<tr>
<td>Between 1 and 5 million</td>
<td>Hubble Space Telescope, US Military Drone, F-22 Raptor</td>
</tr>
<tr>
<td>Between 5 and 10 million</td>
<td>The Mars Curiosity Rover</td>
</tr>
<tr>
<td>Between 10 and 25 million</td>
<td>Total flight software for a Boeing 787, a Chevy Volt</td>
</tr>
<tr>
<td>Between 25 and 50 million</td>
<td>Microsoft Office 2013, Windows 2000</td>
</tr>
<tr>
<td>Between 50 and 100 million</td>
<td>U.S. Army Future Combat System, Large Hadron Collider, Facebook, Mac OS X Tiger</td>
</tr>
<tr>
<td>Over 100 million lines</td>
<td>Embedded software for a modern luxury car, the U.S. healthcare.gov web site</td>
</tr>
</tbody>
</table>

Table 1: A comparison of code amounts. (SOURCE: informationisbeautiful.net)

Advances in technology and increasing product complexities are bringing new challenges to carmakers as they work to ensure the safety and security of today’s road vehicles.

Automotive safety functions are increasingly carried out by electric, electronic, and programmable safety-related systems. This trend led to the development of ISO 26262, an international standard that addresses the functional safety of electrical and electronic systems within road vehicles. It is based on IEC 61508.

Carmakers can use integrated, end-to-end product development management solutions to help prove compliance with ISO 26262. These solutions track all requirements and artifacts associated with the development process and automatically generate the reports and traceability matrices that act as evidence of compliance.
To better understand the benefits of a product development solution, let's take a high-level overview of ISO 26262. Then we'll look at Seapine’s product development solutions to see how they help companies meet the requirements and challenges the standard presents.

**An Overview of ISO 26262**

ISO 26262 addresses the safety of electrical and electronic systems installed in “series production passenger cars” with a maximum gross weight of 3500 kg.

The standard consists of nine normative parts and a guideline for the ISO 26262 as the tenth part. Part Six of the standard details the steps developers must take to ensure the safety of the software component of a safety-related system.

Like its parent standard, ISO 26262 is a risk-based safety standard, where the risk of hazardous operational situations are qualitatively assessed and safety measures are defined to avoid or control systematic failures and to detect or control random hardware failures, or mitigate their effects.

ISO 26262 is based on the concept of a safety lifecycle, shown in Figure 1, which consists of six phases: management, development, production, operation, service, and decommission.

**Seapine Software’s Functional Safety Solutions**

Seapine’s comprehensive and flexible solutions offer:

- Requirements management, impact analysis, and traceability
- Task and issue management
- Audit logging and electronic signatures
- Process automation and enforcement
- Centralized, secure storage of intellectual property
- Role-based security
- Metrics and reporting for management
- Support for any development process (V-Model, Agile, Waterfall, etc.)
The goal of the standard is to maximize product safety by requiring specific steps to be followed during each phase. This ensures that safety is taken into consideration from the earliest concept to the point when the vehicle is retired from use. Seapine’s solutions help in the development phase.

ISO 26262 covers functional safety aspects of the entire development process, including such activities as requirements specification, design, implementation, integration, verification, validation, and configuration.

**Automotive Safety Integrity Level (ASIL)**

A key concept in ISO 26262 is the **automotive safety integrity level** (ASIL), a measurement of the risk imposed by a specific system component. As risk increases, more stringent methods must be employed to ensure safety. There are four ASIL values, named A-D, in which A is the minimum level of risk, and D is the maximum. The ASIL for each component in a system is determined by three factors: **severity**, **exposure**, and **controllability**.

**Severity** is a measure of the health consequences of an event. There are four classes of severity:

- S0: No Injuries
- S1: Light to moderate injuries
- S2: Severe to life-threatening (survival probable) injuries
- S3: Life-threatening (survival uncertain) to fatal injuries
**Exposure** is the likelihood of the conditions under which a particular failure would result in a safety hazard. The probability of each condition is ranked on a five-point scale:

- E0: Incredibly unlikely
- E1: Very low probability (injury could happen only in rare operating conditions)
- E2: Low probability
- E3: Medium probability
- E4: High probability (injury could happen under most operating conditions)

For example, a failure of the headlights would result in a hazard when driving at night, when raining, or during other conditions which result in poor visibility. These conditions would be considered highly probable due to their regular occurrence.

**Controllability** is a measure of the probability that harm can be avoided when a hazardous condition occurs, either due to actions by the driver, or by external measures. If the brakes fail to engage when the brake pedal is pressed, for example, the driver could use the emergency brake instead.

The controllability of a hazardous situation is ranked on a four-point scale:

- C0: Controllable in general
- C1: Simply controllable
- C2: Normally controllable (most drivers could act to prevent injury)
- C3: Difficult to control or uncontrollable

Once the severity, probability, and controllability have been determined, Table 4 of Part 3 (ISO 26262-3) is used to determine the ASIL, as shown in Figure 2.

ASILs range from ASIL D to QM. ASIL D represents the highest degree of automotive risk, requiring the highest level of safety requirements. QM represents an application with no automotive risk, and therefore no safety requirements to manage under the ISO 26262 safety processes; only quality management processes. The intervening levels are a range of intermediate degrees of risk and degrees of safety requirements needed.
Seapine Helps Prove Compliance

Seapine’s integrated product development management solutions, which include TestTrack and Surround SCM, offer significant productivity and cost benefits for companies that must comply with the ISO 26262 standard. Together, TestTrack and Surround SCM make compliance verification easier, less error prone, and more cost effective by automating the creation, management, maintenance, and documentation of requirements traceability.

With TestTrack managing all product development and testing artifacts and Surround SCM managing the code, Seapine offers a tightly integrated solution that covers the entire development lifecycle prescribed in ISO 26262.

Seapine Product Development Management Solution

Designed for the most demanding product development environments, Seapine’s product development lifecycle management solutions are scalable, feature-rich, team-based solutions for requirements
management, issue tracking, software configuration management, and automated software testing. Our solutions seamlessly integrate these processes to provide end-to-end traceability of artifacts and more efficient control of the product development process.

**Automatic ASIL Calculation and Tracking**

TestTrack includes calculated fields, which allow teams to configure custom fields to automatically calculate numeric, text, date/time, pop-up item, and time span values based on other field values. This feature can easily be customized to calculate ASILs for system components automatically.

With TestTrack's calculated fields, there's no need to export data to Excel or another tool to start your risk assessment process. Teams can capture the severity, exposure, and controllability scores in custom fields, and TestTrack will then multiply those scores to get the ASIL.

**Figure 3:** Teams can use TestTrack's calculated fields to automatically calculate ASILs.

Users can also create Home page widgets in TestTrack to highlight important metrics like ASILs. With ASIL widgets, team members can quickly see how many system components of each ASIL classification need to be addressed. Clicking on the widget will take the user to a list of components.
Requirements Management

TestTrack centralizes requirements management and keeps all stakeholders informed of new and changed requirements, makes participating in the review process easy, and ensures everyone understands the impact changes will have on a project.

Requirements can be organized into requirement documents, and users can easily structure document hierarchies and share common requirements between documents for improved reusability.

Track Everything That Defines a Requirement with TestTrack

• Details, description, images, etc.
• Review notes, conversations, and questions
• Change history, workflow, etc.
• Baselines and versioning
• Links to related artifacts including risk, tests, etc.
Requirements can be grouped into requirement documents, and users can easily organize the hierarchy and share common requirements between documents for improved reusability.

**Risk Management**

While risk can be managed with documents or spreadsheets, TestTrack makes risk analysis and mitigation processes faster and easier by automating traceability matrices and risk reports. Users can easily conduct risk analyses (such as FMEAs) and continually monitor and enforce risk mitigation measures as the product moves through the development cycle.
Test Management

Testing complex products requires thousands of unique test cases, the time to execute them, and the ability to efficiently manage the results. TestTrack provides a complete solution to create, organize, execute, measure, and report on manual and automated product testing.

TestTrack’s centralized test management helps the team work together to create, organize, run thousands of test cases, track results, and measure progress.

Track All Testing Artifacts with TestTrack

- Test case details
- Test steps
- Variants
- Test runs
- Workflow
- Email conversations
- Links to requirements and issues

TestTrack simplifies managing large numbers of test cases and results by grouping them into test sets for better organization and reporting. For example, all tests for alpha testing can be included in one test set, and all tests for beta testing can be included in a separate set.

To enable reuse of repetitive test steps, users can share test case steps with other test cases. TestTrack can also automatically create test cases by intelligently recording a user’s actions during manual or exploratory testing. With TestTrack running in the background, the user builds a detailed history of the test session, which can be saved as a step-by-step test case for future re-use.

Figure 7: TestTrack enables users to create reusable test case steps that can be shared with other test cases.
Issue Management
TestTrack provides centralized management of issues, feature requests, and other tasks. This keeps the team in sync regarding outstanding issues, enables analysis and investigation of recurring problems, and allows tracing issues back to their source.

Work item information is included in the traceability matrix to provide a foundation for ensuring product quality. In addition, the team can use this data to strengthen risk analysis and mitigation activities. It becomes much easier to find the root cause of issues, for example, and take corrective action when issues and requirements are linked.

TestTrack’s built-in reports help teams evaluate overall product quality levels and ensure risk mitigation strategies are working.

Figure 8: TestTrack enables users to track everything about an issue.

Change Management
Change is constant in product development and often occurs at a blistering pace. Efficiently controlling and tracking change is critical to maintaining functional safety.

Surround SCM manages all changes to the product’s digital assets (e.g., source code, database files, and graphics) and makes them available to the team anytime and anywhere.

TestTrack’s impact analysis reports make it easy to assess the impact of a requirement change before it is made. Users can perform an impact
analysis to view the related items, assess the risk of making changes, and identify items that will be impacted by the change.

TestTrack also includes suspect item flagging, which streamlines and automates change reviews by determining which linked items (requirements, test cases, defects, change requests, etc.) need to be reviewed when a related item changes.

Software Configuration Management

Seapine’s configuration management solution, Surround SCM, manages all changes to a product’s code base. Surround SCM provides a variety of advanced capabilities for users including flexible branching and merging, integrated code reviews, line-by-line change history annotation, and more.

Branching and merging provide effective management of product versions throughout the product’s lifecycle. Surround SCM does not impose a branching process on users—branching configuration depends on a company’s needs and business processes.

Integrated code reviews provide a way to request feedback and approval before committing changes to the code base. Reviewers can make comments directly in the code review, while the workflow engine manages the review and approval process.

Figure 9: Integrated code reviews provide a way to group related files or changes without affecting current file contents.

Surround SCM’s graphical file history window gives users a high-level view of the file history, making it easy to see file changes across different releases and versions. Users can interactively trace a file’s history, see what’s different between any two versions, and gain insight into source code changes. In addition, they can get a graphical view of the branch structure to see how different product versions relate to each other.
Traceability

The traceability matrix serves in part to guarantee that all necessary operations have been carried out to demonstrate that the required software systematic capability has been achieved, as required by ISO 26262.

With TestTrack's traceability features, however, it can be much more than a checked off item on an audit checklist. TestTrack will generate and maintain a traceability matrix to connect functionality safety requirements with product specifications, help the team estimate how many tests will be needed, provide visibility into the impact of change throughout the product development cycle, and make providing proof of compliance much easier.

TestTrack's traceability matrix also makes it easy to quickly perform coverage analysis by viewing the relationships between related items. For example, users can check that at least one test case has been generated for each approved requirement in a project.

Automated linking between requirements, risk, tests and issues makes all of this possible without adding overhead to a team's already busy workload.
Customizable reports and charts help measure impact, burn down rates, track project progress, and measure productivity to stay on top of the project schedule. TestTrack’s reports provide real-time insight into every aspect of the project, and enable users to quickly spot trends and identify potential problems before they negatively impact the project.

Figure 11: TestTrack’s traceability analysis feature makes it easy to quickly perform coverage analysis.

Figure 12: TestTrack provides real-time reporting across all development and testing artifacts.
Workflow and Process Automation

Safety-critical companies have a wide range of artifacts and work items to track—everything from requirements and specifications to test cases and defects, even unique compliance specifications. Using Seapine solutions, organizations can more easily manage all of these assets enterprise-wide and at the same time standardize their processes—tying together departments, remote offices, and even customers.

Consistency and predictability are two key focuses for companies today, making sure they deliver products that meet customer needs on time and within budget. On top of that challenge, there's the need to prove regulatory compliance as part of the product delivery process. Centralizing the management of product development assets, and enforcing a consistent process across disparate teams is critical in those kinds of environments.

Collaboration

Sharing information is a critical success factor for any product development team, given the nature of today's distributed organizations. TestTrack’s communication and collaboration features ensure team members stay informed of each other’s tasks and progress, with all conversations and decisions stored in a centralized repository.

TestTrack streamlines the development lifecycle with automatic assignments of work items and a powerful rule-based email notification system that keeps team members informed of work assignments, high priority issues to monitor, test failures, and more.

With Surround SCM, end-to-end traceability enables users to release features and fixes rather than individual file changes. By linking code changes to up-stream requirements or issues, Surround SCM enables releases based on all of the changed linked to a specific requirement or defect rather than pushing individual files.

Integrated code reviews provide a way to group related files or changes and request feedback from others without impacting code in production. They know whether a file they are including in the build was code reviewed, can ensure design documents went through the review process, and can control who can make changes to reviewed and approved files.
Conclusion

Functional safety is increasingly challenging. Once deployed into the field, E/E/PE safety-related systems must work dependably. Seapine solutions help carmakers efficiently design, build, and test safety systems.

Functional safety is critical to the automotive industry. Unique development challenges surround designing and building these embedded systems, because software is developed independent of the hardware it will eventually run on. Managing this dual track development of complex systems requires good process with strong integration between development teams and across tools improving efficiency and reducing project risk.

With TestTrack managing all product development and testing artifacts and Surround SCM managing the code and other digital assets, Seapine offers a tightly integrated solution that covers the entire development lifecycle described in ISO 26262.
About Seapine Software
With over 8,500 customers worldwide, Seapine Software, Inc. is the leading provider of quality-centric product development solutions. Headquartered in Cincinnati, Ohio, with offices in Europe, Asia-Pacific, and Africa, Seapine's development solutions help organizations ensure the consistent release of high quality products, while providing traceability, metrics and reporting, and compliance.

Learn more at seapine.com.