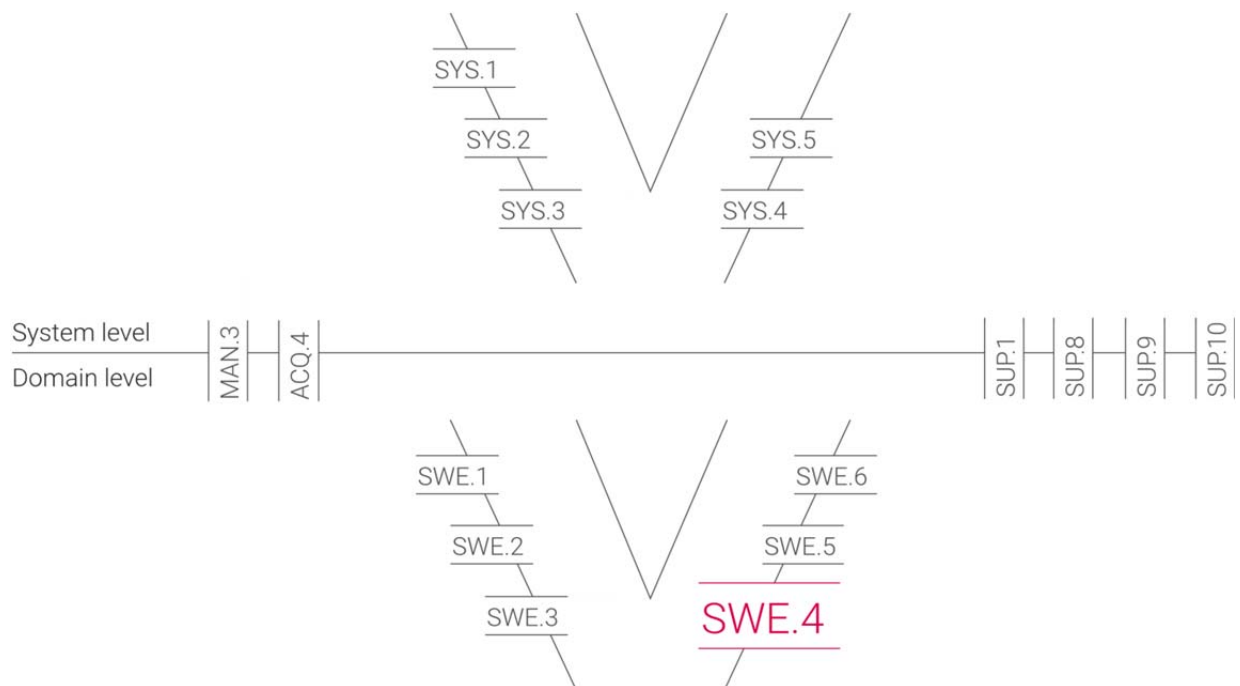


SOFTWARE UNIT VERIFICATION – SWE.4

in Automotive SPICE®

an introduction

Dr. Klaus Hoermann



Kugler Maag Cie is Automotive SPICE® made smart.

1st version – August 2021



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About this white paper

This white paper extends the materials I've covered in my Automotive SPICE[®] tutorial for Beginners on YouTube.

<https://www.kuglermaag.com/swe4>

<https://youtu.be/S9m4PqL-NoA>

Both the YouTube tutorial and this document cover the core concepts and they are not complete by any means. This publication has been prepared for general guidance only. Please do not act according to any information given in this document without receiving specific professional consultancy. The publisher, KUGLER MAAG CIE GmbH, shall not be liable for any damages resulting from any use of the information contained in this report.

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About the author



Hi! I'm Klaus and I started with SPICE back in 1998. Since then I have done hundreds of assessments and trainings. It is my passion to bring hard-to-understand models to life so that normal people can understand them.

I am one of the founders of Kugler Maag Cie and work there as a principal and partner.



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Short summary of the YouTube tutorial

The Software Unit Verification process in Automotive SPICE® (also known as SWE.4) helps your organization to verify that the software units implement the detailed design and non-functional requirements to the desired level of quality.

Unit verification is the first group of tests in a series of subsequent tests.

If you do not do unit verification, there will be two negative consequences:

1. Not all problems are guaranteed to be found later because the subsequent tests have a different focus, such as integration tests and requirements tests.
2. However, if you find such a problem at a higher test level, you will have to re-run most of the tests in between.

The reason for this is that incorrect behavior at the unit level could mask problems at a higher test level.

As you can see, this process helps you find more problems while reducing your effort and costs.



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The following are the 3 most important activities of Software Unit Verification in Automotive SPICE®:

1. **Define a strategy for Software Unit Verification.** As you may know from some of our videos, a strategy is an easy to understand instructional description. This is especially important for larger, distributed projects, so that all people know how to do it.

The main purpose of the strategy is to describe how you intend to demonstrate that the software units comply with the detailed design. Three types of verification are required, and you should explain how they should work:

1. Static and dynamic analysis, that is, checking the code with analysis tools.
2. Code reviews, where coworkers read and review the code provided by a colleague.
3. Unit tests, where written specifications of tests are used to demonstrate compliance with the detailed design.

In addition, Automotive SPICE requires a "regression test strategy". Regression testing simply means that if you change something in a unit, you make sure that everything that hasn't changed still works well.

A practical example: If you use Continuous Integration, you typically run all unit tests again during your nightly tests. So, the strategy would be simply the sentence I just said.



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2. Provide bidirectional traceability and consistency to the detailed design. Three types of traceability are required here, viz. for:

1. each unit in the detailed design you know which is the corresponding test spec. If you can do this vice versa, then the traceability is bidirectional.
2. each unit you know the results of code reviews and static analysis.
3. each unit test spec you know the unit test results.

Now what does consistency mean? For example, for the relationship between a unit in the detailed design and the corresponding test spec consistency would require that

1. the unit is linked to the correct test (and not to the test of another unit)
2. this test is suitable to test the unit completely.

If this is not the case, additional tests must be linked.

Consistency also requires that the tests actually test the unit correctly.

In other words: no faulty tests.

3. Summarize and communicate the test results. This is usually referred to as a test summary report. And this summary report should be sent to the people who need this information, such as the development team, project manager, quality engineers, and so on.

Let's take a closer look at how this report should look.

As the name suggests, it should summarize the results and hide unnecessary details.

What is the main message that the summary report should convey?

It shall show compliance with the detailed design.



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I'll give you a counterexample that I often see in assessments:

The report contains pie charts showing the 1520 tests that should have been performed, but of which 112 could not be performed and 89 tests failed. That's it. There is no information as to why the 112 tests could not be carried out and what the risks are.

There is also no information about how big the problem is with the 89 failed tests. Nor does the report show compliance with the detailed design. In fact, the detailed design is not mentioned at all. They would have to relate the pie chart to the 956 software units, not just to the 1520 tests. I think you have understood the point. This of course leads to weaknesses in the assessment.



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Software Unit Verification – the process according to Automotive SPICE®

The purpose of the Software Unit Verification Process is to verify software units and to provide evidence for compliance of the software units with the software detailed design and with the non-functional software requirements.

BP1: Develop software unit verification strategy including regression strategy. Develop a strategy for verification of the software units including regression strategy for re-verification if a software unit is changed. The verification strategy shall define how to provide evidence for compliance of the software units with the software detailed design and with the non-functional requirements.

NOTE 1: Possible techniques for unit verification include static/dynamic analysis, code reviews, unit testing etc.

BP2: Develop criteria for unit verification. Develop criteria for unit verification that are suitable to provide evidence for compliance of the software units, and their interactions within the component, with the software detailed design and with the non-functional requirements according to the verification strategy. For unit testing, criteria shall be defined in a unit test specification.

NOTE 2: Possible criteria for unit verification include unit test cases, unit test data, static verification, coverage goals and coding standards such as the MISRA rules.



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NOTE 3: The unit test specification may be implemented e.g. as a script in an automated test bench.

BP3: Perform static verification of software units. Verify software units for correctness using the defined criteria for verification. Record the results of the static verification.

NOTE 4: Static verification may include static analysis, code reviews, checks against coding standards and guidelines, and other techniques.

NOTE 5: See SUP.9 for handling of non-conformances.

BP4: Test software units. Test software units using the unit test specification according to the software unit verification strategy. Record the test results and logs.

NOTE 6: See SUP.9 for handling of non-conformances.

BP5: Establish bidirectional traceability. Establish bidirectional traceability between software units and static verification results. Establish bidirectional traceability between the software detailed design and the unit test specification. Establish bidirectional traceability between the unit test specification and unit test results.

NOTE 7: Bidirectional traceability supports coverage, consistency and impact analysis.

BP6: Ensure consistency. Ensure consistency between the software detailed design and the unit test specification.



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NOTE 8: Consistency is supported by bidirectional traceability and can be demonstrated by review records.

BP7: Summarize and communicate results. Summarize the unit test results and static verification results and communicate them to all affected parties.

NOTE 9: Providing all necessary information from the test case execution in a summary enables other parties to judge the consequences.

Output Work Products: Test plan, test specification, communication record, review record, traceability record, verification results, test result, analysis report



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Advanced tutorial about Software Unit Verification

What is the benefit of Software Unit Verification?

Verified software units are ready to be integrated into a product for further verification and validation. Documented tests and results are available for use in regression testing. Traceability provides a clear linkage between the software units, their detailed design, and all unit verification results.

What is the content of the Software Unit Verification Process?

- A unit verification strategy for the verification and re-verification of software units is determined by combining code reviews, static code analysis, dynamic code analysis and software unit tests that supports the desired level of quality.
- Also, application parameter combinations must be taken into account in the tests (BP1).
- The criteria for the verification of the software units are defined. This includes test cases, peer review checklists for source code reviews, and prescriptions for the static analysis and test coverage (BP2).
- The software units are verified according to the strategy using the verification criteria (BP3, BP4).
- The traceability between the software units and the detailed design and the test results is ensured and checked for consistency. In



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addition, consistent traceability between the test specs and test results is ensured (BP5, BP6).

- A summary of the test results and static verification results is created and communicated to the appropriate parties (BP7).

Experiences, problems and hints:

- »Static verification« means verifying code without actually executing the code. This comprises code reviews and static code analysis.
- Defining the desired level of quality for units will help to formulate an appropriate strategy to achieve it.
- Project delivery pressure, developer laziness and embedded challenges often lead to skipping effective unit testing, or fooling oneself into thinking that testing the unit implicitly in the full context of the rest of the software is a better, or sufficient testing. It is actually rare that a software unit is not able to be isolated and tested effectively with modern tools.
- Unit verification often needs to align with other standards e.g. ISO 26262.
- Unit testing should include coverage of all logic – branches and paths, internal and external interfaces, dynamic behaviors, boundary conditions, error checking, and calculations etc.
- Appropriate peer reviews should be performed based on the desired level of quality for the unit, for example inspection for units that are ASIL D, peer reviews for non-ASIL related units.
- All aspects of the unit test must be documented and demonstrable. It is expected that the planning of the software unit test, the verification



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criteria, the test specifications and the test results are documented and available.

- Traceability to the design and software unit test cases is often ensured using naming conventions.



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