IEC TS 61508-3-1

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TECHNICAL SPECIFICATION

Functional safety of electrical/electronic/programmable electronic safety-related systems –
Part 3-1: Software requirements – Reuse of pre-existing software elements to implement all or part of a safety function

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INTERNATIONAL
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Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC TS 61508-3-1, which is a technical specification, has been prepared by subcommittee 65A: System aspects, of IEC technical committee 65: Industrial-process measurement, control and automation.

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
65A/780/DTS	65A/802/RVC

Full information on the voting for the approval of this technical specification can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 61508 series, published under the general title *Functional safety of electrical/electronic/programmable electronic safety-related systems*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- transformed into an International standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

INTRODUCTION

The requirements set out in this technical specification deal with the reuse of software elements when they are intended to form part of a safety function.

In many fields of automation, software elements are used today in support of safety functions. Such applications will certainly be further developed and extended. Software engineers, however, do not always wish to write the software for these applications from scratch, but will in many cases use already existing software and integrate it with the new application which might be slightly different from the one for which the software was originally specified.

In IEC 61508-3:2010, a requirement is given in 7.4.2.12. It offers three routes to the achievement of the necessary integrity for the pre-existing software element. The requirements to comply with the second route, Route 2_s, are defined in IEC 61508-2:2010, 7.4.10.

This entails that IEC 61508-3:2010 –dealing solely with software –refers to requirements in IEC 61508-2:2010 which concerns complete systems including hardware but excluding software (see IEC 61508-2:2010, 1.1 enumeration "e").

This technical specification defines the requirements for software elements explicitly, because IEC 61508-2:2010 excludes software, and is intended to replace the text of the second bullet ("route 2_s") of a), 7.4.2.12 in IEC 61508-3:2010 in a future revision of IEC 61508-3.

**FUNCTIONAL SAFETY OF ELECTRICAL/ELECTRONIC/PROGRAMMABLE
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1 Scope

This Technical Specification presents requirements by the application of which pre-existing software elements may be claimed to be proven-in-use for all or a part of safety function(s) of SIL1 or SIL 2.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61508-3:2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 3: Software requirements*

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/

- ISO Online browsing platform: available at http://www.iso.org/obp

4 Requirements

4.1 Notes 1 to 4 below apply to the entire Clause 4 (4.2 to 4.9).

NOTE 1   Any documentation required by a clause in this document could either be available with the pre-existing software or could be included as part of the documentation of the safety related function.

NOTE 2   A reused software function in this document means a function specified on the level of the requirements specification (see IEC 61508-3:2010, 7.2). A reused software function does not refer to a programming language construct.

NOTE 3   Conditions are set for the data on the history of the pre-existing software in 4.2 b) and c). The fulfilment of these conditions does not entail that the software is deterministic: hidden internal states of the software can affect its execution even when the required combination as specified in 4.2 b) and c) is exactly the same. The use of pre-existing software is thus restricted by 4.7.

NOTE 4   In some cases (e.g. input data are analogue data or a clock signal) the demonstration of proven-in-use for software could be difficult.

4.2 An element shall only be regarded as proven-in-use when:

a) its description:

   1) exists and is available;

   2) fulfils the requirements of IEC 61508-3:2010, 7.2;

   3) describes the previous use,

and

b) the execution of the software with all combinations of all claimed

   – combinations of input data,

   – sequences of execution of the reused software function(s),

   – timing relations within sequences of execution of the reused software function(s)
      which will occur in the intended use are documented;

and

c) combinations of all

   – input data,

   – sequences of execution of the reused software function(s),

   – timing relations within sequences of execution of the reused software function(s)
      which are not part of the proven-in-use claim, comply with 4.8,

and

d) the combinations described in 4.2 b) that will be used in the intended use have occurred in
    the previous use with the same relative frequency. This future frequency shall be justified
    in comparison to the previous use and documented.

and

e) there is adequate evidence to demonstrate the completeness of the documentation,

and

f) the element together with the hardware on which it will run will be subject to documented

   – analysis of any operational experience of the integrated hardware and software
      element;

   – suitability analysis of the hardware and software element;

   – testing of the hardware and software element. This documentation includes:

      • specification of the goals of the test runs from the properties documented in 4.2 a),
         b) and d) above;

      • details of the testing for each individual goal;

      • an estimate of the confidence with which the testing established each individual
         goal;

      • a demonstration that the estimated confidence is appropriate to the goal and the
         test results.

NOTE 1   Suitability analysis and testing focuses on the demonstration of a hardware and software element's
performance within the intended application. The results of existing analyses and testing could be taken into
account. This includes functional behaviour, accuracy, behaviour in the case of a fault, time response, response to
overload, usability (e.g., avoidance of human error) and maintainability.

NOTE 2   A mathematical partitioning of the input data can be helpful to identify all proven-in-use combinations.

NOTE 3   By "input data" is meant all input data to the software element. For example, it can be that the hardware
on which the software element runs generates internal data that are input to the software, such as diagnostics.

NOTE 4   The timing relations most often found and most in need of verification are linear timing relations of the
form (fastest possible time <= execution time <= longest possible time). There are practical methods for verifying
and checking the mutual consistency of timing requirements of such a form.

4.3   The documentary evidence required by 4.2 shall

a) demonstrate that the following features and phenomena of the previous experience
   evaluated for the proven-in-use claim are identical in the intended use of the element:

   – hardware (e.g. processor, memory, clock, bus behaviour) and demand profiles;

- configuration (e.g., compiler options used in compiling the source code for the proposed use, initialisation of program variables and constants, the hardware configuration on which the software will execute);
- software interfaces;
- libraries (including source code libraries as well as libraries of binary code);
- operating system, interpreters (for example, those used to emulate processor architectures on processors which do not share that architecture);
- translator (compiler), linker, code generators;

and

b) contain a complete description of the conditions of use of the pre-existing software.

NOTE 1   The conditions of use (operational profile) include all the factors that can trigger systematic faults in the hardware and software of the element. For example additional modes of use, functions performed, human factors.

NOTE 2   Much of this information can be located in the safety manual (see IEC 61508-3:2010, 7.4.2.12).

4.4   The documentary evidence required by 4.2 shall demonstrate that there was a comprehensive failure detection in the observation period, that is, for the time period in which the behavior of all

- proven-in-use combinations of input data,
- sequences of execution of the reused software function(s),
- timing relations within sequences of execution of the reused software function(s)

  was observed. It shall be demonstrated that any individual failure caused by the software would have been detected and reported.

The documentation of, analysis of, and evaluation of the consequences of reported failures shall be provided.

NOTE 1   The collection of evidence for proven-in-use elements requires an effective system for reporting failures.

NOTE 2   This technical specification does not use the concept of probabilistic failure rate for software.

4.5   Differences between the previous conditions of use (see 4.3 Note 1) and those that will be experienced by the PE safety-related system shall be documented. An impact analysis on the differences shall be carried out and documented using a combination of appropriate analytical methods as well as specific testing, in order to demonstrate that the likelihood of systematic faults which could cause dangerous failures is low enough that the required safety integrity level(s) of the safety function(s) using the element is achieved.

4.6   A proven-in-use safety justification shall be documented, using the information available from 4.3, that the element supports the required safety function with the required SIL. This shall include:

a) derivation from the software safety requirements specification (see IEC 61508-3:2010, 7.2) of the PE safety-related system;

b) the results of testing the element for the intended application;

c) the documentary evidence as described in 4.3;

d) the proof that the element has adequate previous use.

4.7   The requirements of this document shall only be used when reusing software for SIL 1 and SIL 2.

NOTE   The limitation of the use of proven-in-use software to SIL 1 and SIL 2 is due to the fact that the methods classified as HR from the tables in IEC 61508-3 2010, Annexes A and B, up to SIL 2 mainly address only black-box aspects of behaviour.

4.8   Evidence shall be given that reused software functions of the pre-existing software that have not been adequately (in accordance with 4.2, 4.3 and 4.4) covered in the proven-in-use demonstration, have no adverse affect on the safety integrity of the E/E/PE safety-related system.

NOTE   This requirement can be achieved by ensuring that the reused software functions are physically or electrically disabled or demonstration that the input data for the software are restricted in a way that these functions are excluded from the operational configuration, or by other forms of arguments and evidence.

4.9   After any modification at all, the formerly proven-in-use software shall no longer be taken to be proven-in-use. Any future modification to proven-in-use software shall comply with the requirements of IEC 61508-3:2010, 7.8.

NOTE   Modified software is not any more "proven-in-use", and therefore falls outside the scope of this document.