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TECHNICAL SPECIFICATION

colour inside

Reliability of industrial automation devices and systems – Part 1: Assurance of automation devices reliability data and specification of their source

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RELIABILITY OF INDUSTRIAL AUTOMATION DEVICES AND SYSTEMS –

Part 1: Assurance of automation devices reliability data and specification of their source

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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.

Technical Specification IEC TS 63164-1 has been prepared by IEC technical committee 65: Industrial-process measurement, control and automation.

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

DTS	Report on voting
65/744/DTS	65/767/RVDTS

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 of the IEC 63164 series, published under the general title, *Reliability of industrial automation devices and 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 web site 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- withdrawn,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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

Reliability data of automation devices is often used by assessors and system integrators to predict the properties of a complete system. The assessors and system integrators need to know how this data was acquired. This specification gives guidance to device manufacturers on how to present the reliability data of their devices and how to indicate the source of the reliability data in a manner that assessors and system integrators can make best use of. This includes the specification of reference conditions.

Three methods of data acquisition are distinguished:

1) Calculation. This is the preferred method for electronic devices.
2) Observation of devices in the field. This is the preferred method if no relevant data is available to make a forecast by calculation.
3) Laboratory tests. This is the preferred method for mechanical and electromechanical devices. Laboratory durability tests are, however, not deemed to be suitable if said devices will operate in the low demand mode (in the sense of IEC 61508-4:2010, 3.5.16).

NOTE Burn-in and break-in are not considered in this specification and will be addressed in future documents.

This specification is the first part of the series. This part of IEC 63164 concentrates on reliability data, including assurance of reliability data and methods of field reliability data collection. How to get data from calculation and laboratory tests is described in other documents. Therefore, this part will concentrate on random hardware failures, but it is recognized that it is difficult to distinguish between random hardware failures and systematic failures when collecting field data.

Future parts can include following subjects:

– reliability at system level;
– monitoring the automation device in the field;
– user guide.

RELIABILITY OF INDUSTRIAL AUTOMATION DEVICES AND SYSTEMS –

Part 1: Assurance of automation devices reliability data and specification of their source

1 Scope

This part of IEC 63164 provides guidance on the assurance of reliability data of automation devices. If the source of this data is calculation, guidance is given on how to specify the methods used for this calculation. If the source is from observation of devices in the field, guidance is given on how to describe these observations and their evaluations. If the source is the outcome of laboratory tests, guidance is given on how to specify these tests and the conditions under which they have been carried out.

This document defines the form to present the data.

The components considered in this document are assumed not to need any break-in phase before full range usage.

When devices are used for functional safety application, the requirements of IEC 61508 (all parts) and related standards are considered.

2 Normative references

The following documents are referenced in the text in such a way that some or all of their content constitutes requirements for 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 60300-3-2:2004, *Dependability management – Part 3-2: Application guide – Collection of dependability data from the field*

IEC 60300-3-5:2001, *Dependability management – Part 3-5: Application guide – Reliability test conditions and statistical test principles*

IEC 61649:2008, *Weibull analysis*

3 Terms, definitions, symbols and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

3.1.1
assurance of reliability data
outcome of having the needed supporting information such that the reliability data can be trusted, verified and audited

3.1.2
B_{10} threshold
time until 10 % of the components fail

Note 1 to entry: The applicable time interval is dependent on the nature and application of the asset and can be elapsed time, operating hours, number of cycles, etc.

Note 2 to entry: For this document, an average failure rate is calculated from the B_{10} threshold by dividing 10 % with the B_{10} threshold in hours. The influence of infant mortality is neglected and increasing failure rate is assumed only significant after B_{10}.

Note 3 to entry: Once the B_{10} threshold is reached, the failure rate is assumed unacceptable for pneumatic and electromechanical components.

3.1.3
burn-in
process conducted with the sole intention of stabilizing parameters

Note 1 to entry: Burn-in is an accelerated conditioning by operating the item under its operating electrical load at an elevated temperature, which is generally the maximum operating temperature that does not exceed the thermal rating of the device.

3.1.4
failure rate
λ
limit, if it exists, of the quotient of the conditional probability that the failure of a non-repairable item occurs within time interval $(t, t + \Delta t)$ by Δt, when Δt tends to zero, given that failure has not occurred within time interval $(0, t)$

Note 1 to entry: See IEC 61703, *Mathematical expressions for reliability, availability, maintainability and maintenance support terms*, for more detail.

[SOURCE: IEC 60050-192:2015, 192-05-06, modified – The formula and Note 2 to entry have been deleted]

3.1.5
failure in time
FIT
the number of failures in 10^9 component hours of operation

[SOURCE: IEC 60947-5-3:2013, 2.3.18, modified – "device" has been replaced by "component"]

3.1.6
field data
reliability data observed in the field

Note 1 to entry: The word “field” means the normal working environment of the device.

3.1.7
mean operating time between failures
MTBF
expectation of the duration of the operating time between failures

Note 1 to entry: Mean operating time between failures should only be applied to repairable items. For non-repairable items, see mean operating time to failure (192-05-11).

[SOURCE: IEC 60050-192:2015, 192-05-13, modified – "MOTBF" has been deleted]

3.1.8
mean operating time to failure
MTTF
expectation of the operating time to failure

Note 1 to entry: In the case of non-repairable items with an exponential distribution of operating times to failure (i.e. a constant failure rate) the *MTTF* is numerically equal to the reciprocal of the failure rate. This is also true for repairable items if after restoration they can be considered to be "as-good-as-new".

[SOURCE: IEC 60050-192:2015, 192-05-11 – modified: Note 2 to entry has been deleted]

3.1.9
mission time
T_M
period of time covering the intended use

[SOURCE: ISO 13849-1:2015, 3.1.28, modified – "of an SRP/CS" has been deleted]

3.1.10
random hardware failure
failure, occurring at a random time, which results from one or more of the possible degradation mechanisms in the hardware

[SOURCE: IEC 61508-4:2010, 3.6.5]

3.1.11
reliability

ability to perform as required, without failure, for a given time interval, under given conditions

Note 1 to entry: The time interval duration can be expressed in units appropriate to the item concerned, e.g. calendar time, operating cycles, distance run, etc., and the units should always be clearly stated.

Note 2 to entry: Given conditions include aspects that affect reliability, such as: mode of operation, stress levels, environmental conditions, and maintenance.

[SOURCE: IEC 60050-192:2015, 192-01-24 – modified: Note 3 to entry has been deleted]

3.1.12
systematic failure
failure, related in a deterministic way to a certain cause, which can only be eliminated by a modification of the design or of the manufacturing process, operational procedures, documentation or other relevant factors

Note 1 to entry: Corrective maintenance without modification will usually not eliminate the failure cause.

Note 2 to entry: A systematic failure can be induced by simulating the failure cause.

Note 3 to entry: Examples of causes of systematic failures include human error in

– the safety requirements specification;
– the design, manufacture, installation, operation of the hardware;
– the design, implementation, etc. of the software.

Note 4 to entry: In this standard, failures in a safety-related system are categorized as random hardware failures (see 3.1.10) or systematic failures.

[SOURCE: IEC 61508-4:2010, 3.6.6]

3.1.13
useful life
time interval, from first use until user requirements are no longer met, due to economics of operation and maintenance, or obsolescence

Note 1 to entry: In this context, “first use” excludes testing activities prior to hand-over of the item to the end-user.

[SOURCE: IEC 60050-192:2015, 192-02-27]

3.2 Abbreviated terms

For the purposes of this document, the following abbreviated terms apply.

FIT	Failures in time
$MTBF$	Mean time between failures
$MTTF$	Mean time to failure
T_M	Mission time

4 Form to present reliability data

Generally, the reliability data can be considered from the following aspects.

- Source of data: how to get the reliability data, from calculation/observation of devices in the field/ laboratory test, standards or database.
- Reliability data: Common reliability data such as $MTBF$, λ, $MTTF$, and B_{10}.
- Period of validity, such as T_M.
- Reference conditions: Information about deployment conditions under which a device was observed or which are assumed for its future deployment, such as operating time, exposure time, operating voltage, operating current, duty cycle.
- Reference environment conditions: Information about the reference environment conditions under which the field data was acquired or which are assumed for further deployment, such as temperature, humidity, pressure, corrosion, vibration.
- Events: Information about anything that happened to the automation device during its life and might influence reliability, including failures, repairs, etc.

5 Conformance

A manufacturer of an automation device presenting reliability data of said device in accordance with this document shall provide data according to at least one subclause of Clause 6.

6 Requirements on the assurance of reliability data

6.1 Assurance of reliability data derived from calculation

6.1.1 General requirements

This is the preferred method for electronic devices.

The reliability data derived from calculation shall be obtained according to the following provisions.

- The calculation is based on statistical failure rates obtained from e.g. the manufacturers of components or databases.
- The statistical data obtained are valid only during the mission time of the device.
- The failure rate of the device is derived from calculation based on the failure rates of all the components.

Information about calculation of $MTTF$ and $MTBF$ derived from λ for a device or subsystem can be found in Annex B.