

IO-Link Exceptions

Change and Exception Management

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This document has been prepared by the technology working groups of the IO-Link community. It shall be observed by all users of IO-Link documents.

Any comments, proposals, and requests on this document are appreciated through the IO-Link CR database www.io-link-projects.com. Please provide name and e-mail address.

Login: *IO-Link-Except*

Password: *Report*

Important notes:

NOTE 1 The IO-Link Community Rules shall be observed prior to the development and marketing of IO-Link products. The document can be downloaded from the www.io-link.com portal.

NOTE 2 Any IO-Link device shall provide an associated IODD file. Easy access to the file and potential updates shall be possible. It is the responsibility of the IO-Link device manufacturer to test the IODD file with the help of the IODD-Checker tool available per download from www.io-link.com.

NOTE 3 Any IO-Link devices shall provide an associated manufacturer declaration on the conformity of the device. A corresponding form with reference to relevant documents is available per download from www.io-link.com.


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Conventions:

In this specification the following key words (in **bold** text) will be used:

may: indicates flexibility of choice with no implied preference.

should: indicates flexibility of choice with a strongly preferred implementation.

shall: indicates a mandatory requirement. Designers **shall** implement such mandatory requirements to ensure interoperability and to claim conformity with this specification.

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1 **0 Introduction**

2 **0.1 General**

3 The IO-Link Community elaborated in 2019 a new version of the "IO-Link Interface and System"
4 specification as part of a "Package 2019" consisting of a new "IO-Link Test Specification" and
5 a new "IODD Specification".

6 Current V1.1.2 of the "IO-Link Test Specification" covers only a very small area of exceptions
7 that may occur within IO-Link business. Clauses 4.4. and 4.5 contain the following statements:

8 *If a Device did not pass a certain test case due to measurement values close to the tolerance*
9 *limits or similar situations it is possible to send an informal request to the organization listed in*
10 *Annex D. This request shall be comprehensive enough for the experts to allow for an exception*
11 *under certain conditions or clarification of the specifications. If an exception applies, it shall be*
12 *documented in the user manual mentioning the possible implications.*

13 *Instead of pursuing such a time-consuming and uncertain way, it is highly recommended for the*
14 *applicant to rather strive for a robust implementation and conformity of the Device."*

15 Growing worldwide success of IO-Link has shown that these statements are not sufficient and
16 therefore cause the Community to define a comprehensive strategy and a set of rules as well
17 as to establish stringent procedures.

18 This document is presumed to become a new general policy that can be referenced in the new
19 "IO-Link Test Specification" V1.1.3. Clauses "Introduction" and "Patent declaration" can be
20 omitted in final version.

21 **0.2 Patent declaration**

22 No known patents for this part.

IO-Link Change and Exception Management – Organization and Processes

1 Scope and purpose

Subject matter of the IO-Link Community is a single-drop digital communication interface technology and associated system support and extensions for sensors and actuators in factory automation, starting from the smallest devices up to complex mechatronics elements.

The community is responsible for

- Investigation and evaluation of new requirements,
- Development of technology specifications,
- Development of test specifications and quality assurance policies,
- Information dissemination and marketing,
- International awareness through organizational measures and standardization, and
- Cooperations.

A set of documents, available for download from the IO-Link website, allows for maintaining a high degree of product quality and system interoperability. However, practice shows that even very well-designed specifications and policies may not lead to 100 % success.

There are always deviations in expectations from "Providers" of such documents and from their "Consumers". Usually, the deviations occur at different phases of a product development. The earlier clarifications take place the better for the manufacturer and the community.

It is the purpose of this paper to identify

- possible classes of deviations,
- responsible IO-Link decision bodies, and
- rules to resolve open issues.

A lot of stress and extra work for the IO-Link Community can be avoided, if "Consumers" have easy access to the information in this document and if candidates are informed, when they turn in their IO-Link Community membership application.

2 Overview of documents

The IO-Link Community uses a set of policies to organize work of its members, providers and test centers and to maintain quality assurance (mainly interoperability) of member products as shown in Figure 1.

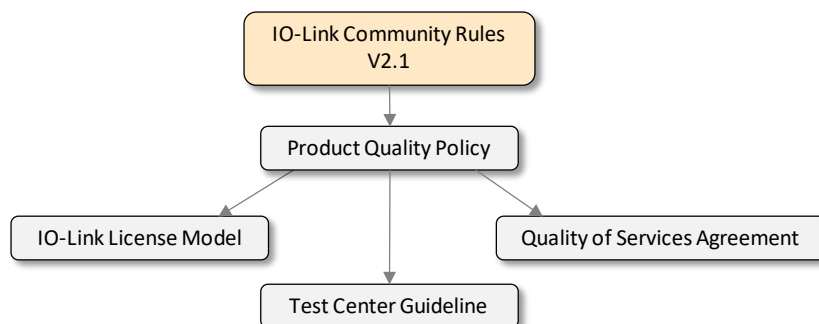


Figure 1 – IO-Link's policies

58 Table 1 provides information about IO-Link's policy documents.

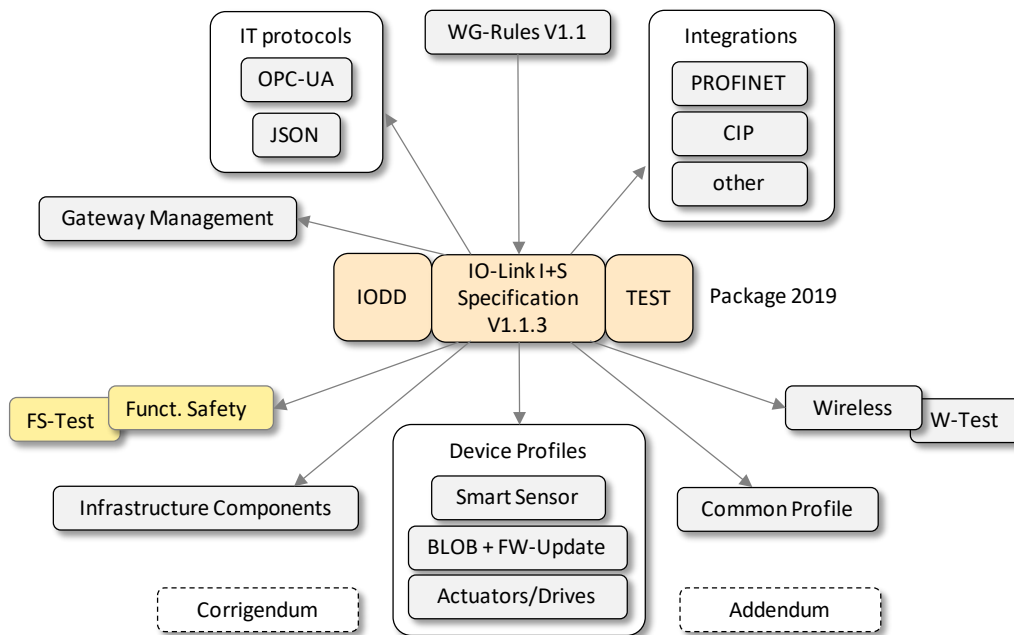
59 **Table 1 – Subject of IO-Link's policy documents**

Title of document	Subject	Tag
IO-Link Community Rules (Body of rules between IO-Link members and the PNO)	This document governs the cooperation between IO-Link members or licensees and the PNO and describes the rights and obligations of the partners.	IOL-BR
Product Quality Policy	This policy describes the procedures necessary for the attainment of a manufacturer declaration for an IO-Link Master and Device. Furthermore, in sections 4 and 5 it gives hints for the successful preparations for the tests as well as describing procedures for brand labelling and dealing with equipment variants.	PQP
IO-Link License Model	This document describes the license model for non-IO-Link Members.	IOL-LM
Quality of Services Agreement	The purpose of this agreement is to establish a quality assurance system between IO-Link Community and the IOL-Competence Centers (IOLCC) for the technologies of IO-Link.	QSA
Test Center Guideline	This document describes the preconditions for becoming a test laboratory accredited by IO-Link community. It additionally describes the rules for the performance of such an IOL Test Center (IOLTC).	TCG

60

61 The worldwide fast-growing acceptance of the IO-Link technology causes an also growing number of technical specifications as shown in Figure 2.

62



63

64 **Figure 2 – IO-Link's specification portfolio**

65 Table 2 provides information about IO-Link specifications and the WG Rules.

66 **Table 2 – Subject of IO-Link specifications and the WG Rules**

Title of document/group	Subject	Tag
Package 2019	This package comprises the specifications of the core IO-Link technology: - IO-Link Interface and System specification V1.1.3 - IO-Link Test V1.1.3 - IO-Link Input/Output Device Description (IODD) V1.1.3	P2019
Device Profiles	Profile specifications can be elaborated for Device families as soon as there are enough supporting member companies (≥ 3).	DevProf

Title of document/group	Subject	Tag
	Characteristics of profiles are so-called FunctionClasses and ProfileIdentifiers (combined FunctionClasses).	
Common Profile	Common rules for Device profile design and common FunctionClasses for Identification and Diagnosis.	ComProf
Infrastructure Components	Specified characteristics of components between Master Port and Device (in progress).	InfraCom
Functional Safety	System extensions for functional safety, test and assessment	FuSafe
Wireless	System extensions for wireless connections and test	WiConn
Gateway Management	Coordination of client accesses to SMI (in progress)	GateMan
IT protocols	Data formats for data exchange in IT networks (OPC-UA, JSON)	ITProto
Integrations	Mappings of IO-Link from and to fieldbus networks (PN, CIP, etc.)	IOLMapp
Corrigendum	It is up to the "owner" (working group) of a document to publish a document with important error corrections.	Corrig
Addendum	It is up to the "owner" (working group) of a document to announce important features planned for next official release.	Addend
Working group rules	How to write a specification, change request (CR) database management, and processing of CRs	WGRules

67

68 **3 Deviations**69 **3.1 Possible classes of deviations**

70 Most of the work within the IO-Link Community is on a voluntary basis and thus it is organized
71 in an efficient manner. Since different groups exist with particular expertise, typical and/or im-
72 aginable incidents are described and sorted in "classes of deviations" for the purpose of direct-
73 ing issues to the right place for resolution.

74 Table 3 includes possible classes of deviations but is not limited to these classes nor to the
75 listed cases.

76 Worst situation for the Community is, when companies try to gain advantages against the com-
77 petition using intended deviations, that are violating specifications/standards. These deviations
78 are reported at a late time, when e.g. ASICs are produced, and devices are already in produc-
79 tion such that the Community is forced to agree.

80

Table 3 – Possible classes of deviations

Class of deviation	Case description	Tag
Change requests	Any bug report or request regarding a particular specification	CR1
	Any bug report or request regarding a particular policy document	CR2
Specification interpretation	It was unclear whether a feature is mandatory or optional	SI1
	It was unclear whether a feature can be used manufacturer specific	SI2
	Feature was not specified clearly or detailed enough (gap)	SI3
	Description/wording was misleading	SI4
	Referenced standards and specifications were outdated/not correct	SI5
	Behavior descriptions were ambiguous	SI6
	Conflicts with IEC 61131-9	SI7
Implementation & test	Value ranges are not correct (physical layer, levels, timings)	IT1
	Behavior is incorrect (sequences, error handling)	IT2
	Feature is missing (e.g. ISDU, M-sequence TYPES, etc.)	IT3
	Service is missing (e.g. SMI)	IT4
	Incorrect manufacturer specific feature (e.g. service)	IT5

Class of deviation	Case description	Tag
	Inappropriate integration (e.g. access conflicts)	IT6
	Inappropriate infrastructure component	IT7
	Inappropriate port extension or function	IT8
IODD issues	Schema modifications	II1
	Inappropriate extensions	II2
	Inappropriate omissions	II3
	Inappropriate embeddings (e.g. other device descriptions)	II4
Manufacturer declaration	Missing or incorrectly described constraints	MD1
	Incorrect references	MD2
Policy interpretation	Incorrect brand labelling	PI1
	Patent issues	PI2
	Membership issues	PI3

81

82 **3.2 Discovery of deviations**

83 The time of discovery of deviations is important for the management of exceptions. All measures
84 of change and exception management are considering these phases.

85

Table 4 – Discovery of deviations

Usage phase	Types of detected deviations	Tag
Reading	Usually, during first reading or later, focus is on typos, wording, comprehension, structure, missing items, inconsistencies, etc.	Reading
Planning	In this phase, focus is for example on mandatory/optional, and inconsistencies.	Planning
Design	This could occur while working on hardware or software design of a Master or Device. It could also be while elaborating a specification for IO-Link system extensions.	Design
Implementation	This could occur while implementing software (state machines, sequence charts, etc.)	Implem
Test	Systematic detection of deviations is the purpose of tests. Test equipment shall be obtainable for anybody at any time (technology provider).	Test
Deployment	The Community strives for a high degree of product quality. Thus, detection of deviations shall be very unlikely.	Deploy

86

87 **4 Related IO-Link bodies**

88 The related IO-Link bodies for the given subjects are listed in Table 5.

89

Table 5 – Related IO-Link bodies

IO-Link body	Related responsibilities
Working Group	Group of experts to specify a particular technology, or profile, or test cases, or policy, or an adhoc issue. Group maintains and processes one or more related change request database projects. Group can perform marketing issues.
Competence Center	Group of experts of technology providers, or consultants, or institutes, etc.
Test Center	Group of experts of companies performing tests and/or assessments
CoreTeam	Group of experts responsible for the core IO-Link technology (Package) and for system coordination in addition to WG responsibility. This group can be enlarged by additional experts to resolve particular deviations.
Marketing Requirements Team	Any new major system feature shall be checked by this team for market relevance/acceptance prior to incorporation into existing specifications via the Core Team.

IO-Link body	Related responsibilities
Clearing Group	Serious deviations of products discovered either upon request or during testing or upon deployment are to be investigated by this group of experts appointed by Steering Committee.
Steering Committee	This elected group of member representatives is responsible for IO-Link Community strategies, partnerships, technology approval, information dissemination, marketing activities, organizational issues, and conflict resolution ("last resort").

90

91 **5 Management processes**

92 **5.1 Escalation concept**

93 The IO-Link Community is striving for an early alert system, where any deviation is reported as
94 soon as possible.

95 On document level ("Reading" or "Planning"), the IO-Link Community is operating a Change
96 Request database. Anybody in the world can download IO-Link specifications and policies.
97 Whenever such a "Consumer" discovers a deviation (see Table 3 and Table 4) he/she is entitled
98 to enter a report in form of a "change request" (see 5.2).

99 On document level ("Design"), for example development of documents for IO-Link system ex-
100 tensions or integration into fieldbus, IT, or embedded systems, the IO-Link Community refers
101 those developers to its system coordinator, the CoreTeam (see 5.3).

102 On document level ("Design" and/or "implementation"), the IO-Link Community refers "Consum-
103 ers" to Competence Centers, or to the business office that forwards the request to groups or
104 persons in charge (see 5.4). Contact information is available in Annex A.

105 On quality assurance level ("Test"), the IO-Link Community demands for each project test spec-
106 ifications or annexes to technical specifications as a precondition. The Community refers "Con-
107 sumers" to Technology Providers for test equipment, and to Test Centers. In case of deviations,
108 the Technology Providers and Test Centers are in charge to resolve issues together with the
109 corresponding (test) working group (see 5.5). Contact information is available in Annex A.

110 On machine or in the field level ("Deployment"), the IO-Link Community refers to the "Clearing
111 group" (see Table 5), who reports to the Steering Committee. Contact information is available
112 in Annex A.

113 All "consumers" shall be informed about this document and its change and exception strategy
114 on www.io-link.com.

115 **5.2 Change requests**

116 For each publicly available IO-Link document, be it a policy or specification, a CR Database
117 project shall be established by the corresponding working group. The document shall carry
118 access information (login, password) on its second page.

119 Each CR shall be responded within a reasonable time frame. If an immediate answer is not
120 possible, the reader shall at least be informed about the status of the processing. It is not
121 necessary for the working group to inform about all intermediate states due to the complexity
122 and dependencies of many CRs.

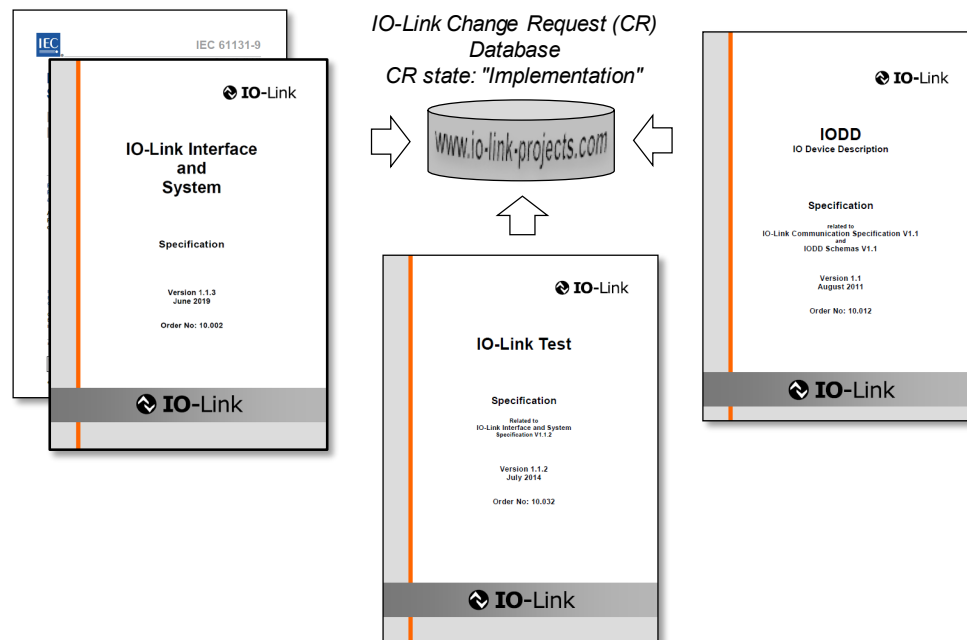
123 Figure 3 shows the example of CR database projects of the core IO-Link technology, where
124 complexity and dependencies are illustrated.

125 In a process of continuous improvement for IO-Link products, the following rule has been es-
126 tablished for all projects:

127 In addition to the basic specification, supplemental information shall be observed for implemen-
128 tation, test, (and assessment) if applicable. Normally, this information is provided by the working
129 group as response to a change request (CR) within the CR-database that is in state "implemen-
130 tation" (and approved by an assessment body in case of functional safety).

131 *Corrigendum*

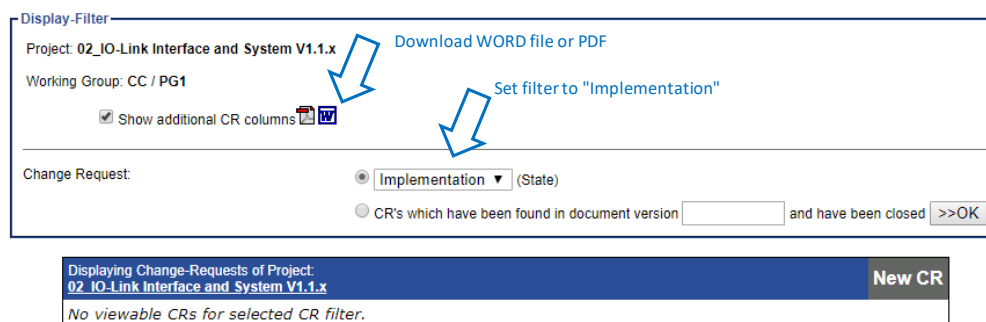
132 The working group can decide to publish these CRs through a separate "Corrigendum" docu-
 133 ment for download on the IO-Link website. However, this measure should be used lightly, since
 134 this document cannot be expected to be error-free and would require a CR database project as
 135 well, whereas the CR database project for the original document always provides up-to-date
 136 information and can be improved directly for immediate access by anybody.



137

138 **Figure 3 – Example: Package 2019 specifications and CR database**

139 Figure 4 demonstrates, how easy it is for the user of a CR database project to download an
 140 excerpt of all CRs in state "implementation". After opening the project, all CRs are visible as
 141 shown in Figure 4. With the help of a "Display-Filter" in section "Change Request", a view on
 142 CRs in state "Implementation" can be selected. It is possible to download this view as a WORD
 143 or PDF file.



144

145 **Figure 4 – Retrieval of information on relevant Change Requests**

146 It is very important for the working groups to focus on precise descriptions of the solutions
 147 within the response field of the CRs. Additional figures, graphs, etc. can be uploaded for ease
 148 of use.

149 *Addendum*

150 Working groups can decide to publish advance information (Preview) on major changes, best
 151 practice patterns (as it happened with Data Storage), or new features (as it happened with SMI).
 152 This preview allows designers to be prepared for the next release. However, "Consumers" can
 153 not raise or enforce a claim, that the content of the Addendum or parts of it will be adopted
 154 100 % or even at all.

155 5.3 Compliance exceptions

156 The system coordinator, that means the CoreTeam, shall be informed by working groups in
157 case of intended system deviations (see 5.1). CoreTeam together with the related WG shall
158 elaborate solutions/compromises to be approved by Steering Committee. Any such system de-
159 viation shall be described in an appropriate way in the corresponding specification and shall be
160 archived in the project database within the project "Compliance exceptions".

161 5.4 Implementation exceptions

162 In cases, where companies are not willing to fit their devices with features they think their cus-
163 tomers do not need and they are not willing to pay for, the IO-Link Community established a
164 "mediator" team to be addressed that is responsible to analyze and manage processing with
165 appropriate bodies in IO-Link (see Table 5). This team suggests a conflict resolution or excep-
166 tions with constraints on manufacturer declaration, user manual, and period of validity or inser-
167 tion in specifications. Approved exceptions shall be archived in the project database within the
168 project "Implementation exceptions".

169 5.5 Test exceptions

170 In order to prevent from surprises at the end of a device development, the IO-Link Community
171 promotes and sponsors quality test tools available at the developer's site and in test centers.
172 The Technology Providers for test equipment are responsible for the frequency of updates, the
173 quality level, and an error/bug fix information system.

174 A certification is not required. Manufacturers shall use the appropriate manufacturer declaration
175 forms provided for download at www.io-link.com.

176 Large companies can afford to organize for an internal test and assessment center. The Com-
177 munity took care for independent IO-Link Test Centers that can be contracted by non-members
178 or smaller companies or businesses to perform test and certification.

179 In cases, where despite all precautions a deviation has been discovered that cannot be fixed at
180 reasonable cost and time, the group of experts mentioned in 5.1 is in charge suggesting a
181 proposal for conflict resolution or exceptions with constraints on manufacturer declaration, user
182 manual, and period of validity. Approved exceptions shall be archived in the project database
183 within the project "Test exceptions".

184
185
186

Annex A
(informative)
Contact information and processing of exception requests

187 Any request for an exception should be sent to the IO-Link organization via email to:

188 **test@io-link.com**

189 Mails to this email address are redirected automatically to the following members of a "media-
190 tor" team coordinating the appropriate activities in bodies of IO-Link (see Table 5):

- 191 • Head of IO-Link quality (responsible for correct processing of exception requests)
192 • Technology providers for tester equipment
193 • Core team
194 • Head of test WG
195 • Head of IODD WG

196

197

Bibliography

- 198 [1] IO-Link Community, *IO-Link Interface and System*, V1.1.3, June 2019, Order No. 10.002
199 or
200 IEC 61131-9, *Programmable controllers – Part 9: Single-drop digital communication in-*
201 *terface for small sensors and actuators (SDCI)*

202

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