IODD

IO-Link Device Description

Specification

related to

IO-Link Communication Specification V1.0

and

IODD Schemas V1.0

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Important notes:

NOTE 1 The IO-Link Consortium Rules shall be considered 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 device shall provide an associated manufacturer declaration on the conformity of the device with the IO-Link Communication Specification and its related IODD, and test documents, 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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Content

Revision Log

Identification	Version	Originator	Date	Change Note / History / Reason
-	1.0	Team Technology	18-Sep-09	Final release of IODD specification
IOL-09-0002	1.0	Team Technology	18-Jan-09	Formal adjustments and errata

1 General

An IODD file is mandatory for an IO-Link device.

IO-Devices are described via a device description. It consists of a set of XML files (text) and PNG files (graphs). These files contain information about the identification of the device, communication characteristics, parameters, process data, and diagnosis data. The XML files (text) consist of two parts.

The default part contains a set of IO-specific variables.

Default part: **IODD-StandardDefinitions1.0.xml**

The vendor specific part contains device specific variables as well as all further information necessary to fully describe the device. Device-specific file names are ordered according to a certain schema (for further information see section “Files”).

Vendor part example: **Vendor-Device-20080313-IODD1.0.xml**

Both files are validated by assigned XSD schemas. The assignment can be found in the header of each XML file. These schemas are owned by the vendor and are not available to third parties.

Both files refer to the same "targetNamespace", which contains information about the year and month of the employed schemas.

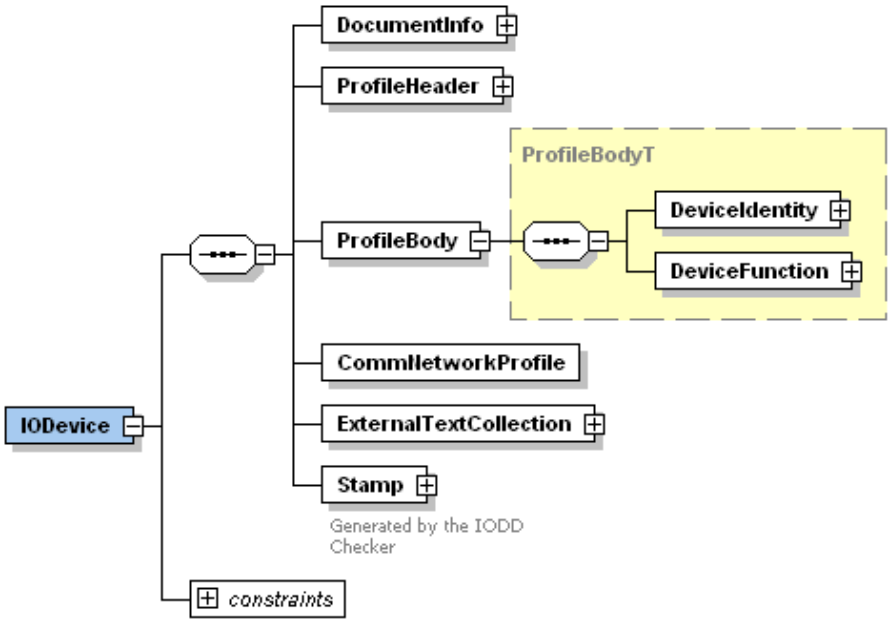
targetNamespace: **http://www.io-link.com/IODD/2008/03**

All XMLs generated by vendors shall be tested by checker software before delivery. This checker is a tool available to IO-Link users. It checks the content of the device description and incorporates the test result as appendix <Stamp> at the end of the XML-file.

The checker only stamps the file if there are no errors reported during the checking process. If there are errors, the file remains unchanged.

A tool or interpreter shall check if there is a stamp. It is recommended to reject the IODD if the stamp is invalid.

2 Structure



This chart shows the approximate structure of an IODD. An IODD has to be divided into the parts DocumentInfo, ProfileHeader, ProfileBody, CommNetworkProfile, ExternalTextCollection and Stamp.

3 Files

Tools must not evaluate the file name; they always evaluate the content. The device-specific file name is only intended for better legibility.

Adherence to the name guidelines makes it possible that all IODDs can be put in a single directory.

File names must not only be different in upper and lower case. Case sensitivity of default parts of file names shall be adhered to.

The following special characters are permitted in vendor name and device name: _, #, -

3.1 Device specific files

<vendor name>**-**<device name>**-**<date of file creation>-**IODD**< schema version >.xml

The IODD must always entirely contain the PrimaryLanguage in English. The IODD may contain further languages. Additionally, there may be XML-language files of other languages added to the IODD. A tool or interpreter must evaluate the IODD according to the language used.

VendorX-DeviceY-20080414-IODD1.0.xml	IODD
VendorX-DeviceY-20080414-IODD1.0-ru.xml	is the additional language file in Russian -> There is one file per language
VendorX-IODD1.0.xsl	is a style sheet for the vendor-specific description of IO-devices for a certain browser (optional); this style sheet must not be given in the IODD.

3.2 Standard definitions file

Name IODD-StandardDefinitions1.0.xml

This file contains all standardized definitions. It has to be available once in the IODD directory. Language-dependent files are labelled as follows:

IO-StandardDefinitions1.0-ru.xml	is the additional language file in Russian -> There is one file per language

Those files are part of the standard and must not be changed. Vendors of tools have to use those files.

3.3 Graph files

The format .png is exclusively used. The same rules for permitted characters apply as in section ‘Files’ (see above).

VendorX-DeviceVariantY-**pic<n>**.png (min.160 x 160 pixel, max. 320 x 320, square)
<n> is the placeholder character for a consecutive number.

VendorX-DeviceVariantY-**icon**.png (48 x 48 pixel)

VendorX-**logo**.png (160 x 90 pixel, landscape format)
The background of the logo should be transparent.

3.4 Schema files

Schema files are needed to display the structure of XML-files or to validate these. The following namespace is used:

http://www.w3.org/2001/XMLSchema-instance

IODD1.0.xsd
IODD-schema; includes the following sub-schemas:

IODD-Primitives1.0.xsd
includes basic schema elements

IODD-Datatypes1.0.xsd
includes schema elements for the definition of file types

IODD-Variables1.0.xsd
includes schema elements for the definition of variables

IODD-UserInterface1.0.xsd
includes schema elements for the definition of the user interface

IODD-Communication1.0.xsd
includes schema elements for the definition of the communication protocol

IODD-StandardDefinitions1.0.xsd
schema for the definition of system-specific elements used to validate the file IODD-StandardDefinitions1.0.xml.

3.5 Language files

The agreement of file names of language files was already described above. There must be only be one file per language. This file must use the same targetNamespace as the IODD and contains an optional DocumentInfo-Header.

The language file also contains a checker-stamp. Only language references that are referenced in the IODD may be stated. Yet there may be fewer language references. In this case, it must be reverted to the text of the PrimaryLanguage.

4 Description mechanisms

4.1 Referencing

Each element that can be referenced within the IODD contains an explicit attribute “id”. The referencing element contains a type-dependent attribute with the following composition: <typ>Id

Examples: textId, datatypId, menuId, variableId

4.2 Text localization

All text components of the different languages which are referenced in the IODD are allocated in the ExternalTextCollection (for further information see “Language-Dependent Description Texts”).

The text components of the different languages are referenced in the relevant location according to a key (textId).

Further languages can be added in an appropriate file (see chapter 3.5).

The PrimaryLanguage in the IODD must be completely available. If there is a further language added in the IODD or in a separate language file, not all entries must be given. In this case, the interpreter has to go back to the entry of the PrimaryLanguage.

4.3 Number formats

Representation of data types:

Data type	Regular expression	Description
BooleanT	“true|false”	
IntegerT bitLength = 2..64	“\-?\d+”	Decimal integer in range $-2^{(bitLength\ -1)}$ ... $2^{(bitLength\ -1)}$ -1
UIntegerT bitLength = 2..64	“\d+”	Decimal integer in range 0 ... $2^{bitLength}$ -1
Float32T	"\-?\d+(\.\d+)?([eE]\-?\d+)?|INF|-INF|NaN"	Single-precision floating point number
OctetStringT	“([0-9a-fA-F][0-9a-fA-F])*[0-9a-fA-F][0-9a-fA-F]”	Bsp: “494F2D4C696e6b”
StringT	“.*”	Sonderzeichen werden entsprechend der XML-Syntax umcodiert. & → & ’→ ' > → > < → < “ → "
TimeT	“\d{4}\-\d{2}\-\d{2}(T\d{2}:\d{2}:\d{2}(\.\d{1,9})?)?”	yyyy-mm-dd[Thh:mm:ss[.fffffffff]] fffffffff = fraction of a second (up to nanosecond)
TimeSpanT	"\-?P(\d+D)?(T(\d+H)?(\d+M)?(\d+(\.\d{1,9})?S)?)?" • If the number of years, months, days, hours, minutes, or seconds in any expression equals zero, the number and its corresponding designator ·may· be omitted. However, at least one number and its designator ·must· be present. • The seconds part ·may· have a decimal fraction. • The designator 'T' must be absent if and only if all of the time items are absent. • The designator 'P' must always be present	Range: from about -24855 to 24855 days Resolution: 1 nanosecond Example: “P445DT12H30M17.100S”

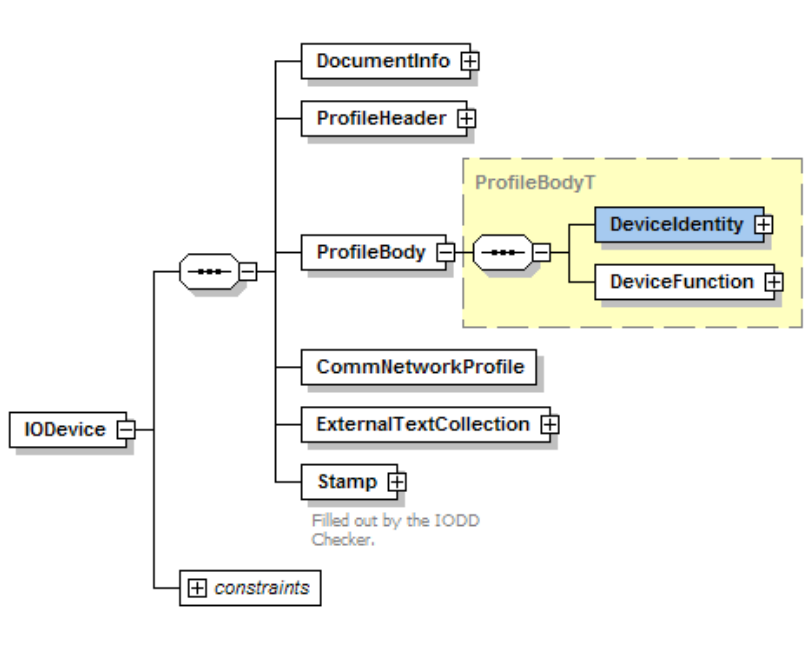
Annotation:

UIntegerT 1 has the values 0 | 1.

4.4 Data types

Standardized data types (e.g. Integer) are described in the appendix of this specification. Further data types can only be defined based on these standardized data types. In order to simplify the reuse of data type definitions, they can be declared and referenced.

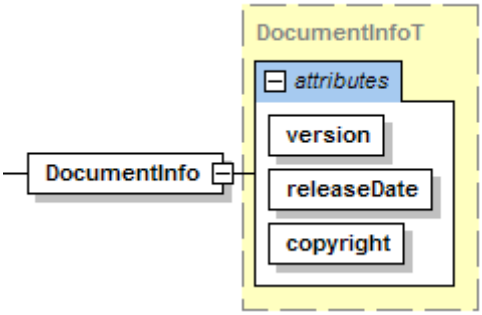
5 Device Description



The graph above shows the basic structure of an IO-device in a device description.

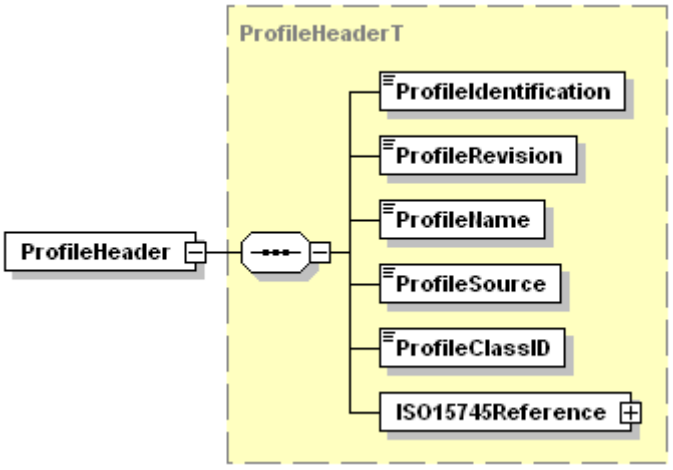
5.1 Metainformation

5.1.1 DocumentInfo



The vendor inserts here the information for the IODD. There are neither any dependencies nor any kind of restrictions. All entries are optional.

5.1.2 ProfileHeader



Within this group, the vendor is obliged to give the following information in plaintext.

ProfileIdentification: „IO-Device Profile“

ProfileRevision: „1.00“

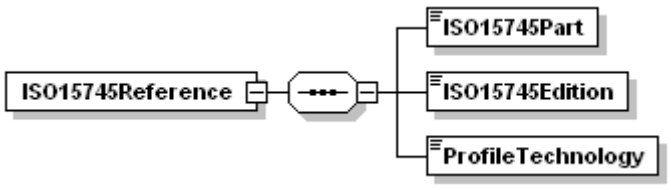
ProfileName: „Device Profile for IO-Devices“

ProfileSource: „IO-Link Consortium“

ProfileClassID: „Device”

ISO15745Reference

Information about the underlying ISO standard



ISO15745Part: „1”

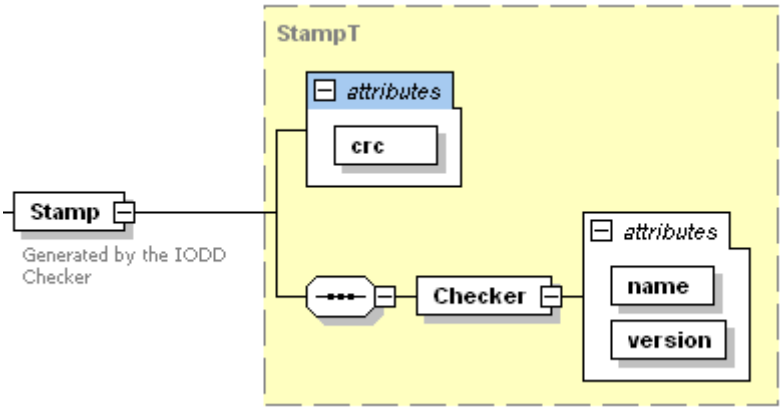
ISO15745Edition: „1”

ProfileTechnology: „IODD”

ProfileBody

ProfileBody contains the description of identity and functionality of the device.

5.1.3 File validation



The entry “Stamp” is conducted by an IODD-checker. This tool intensely tests the IODD if it is conform to this specification. If there are no errors found, the IODD is then stamped with the element “Stamp”. The stamp contains a CRC about the content of the IODD so that an interpreter can find out, if the IODD has been changed by the checker since the last successful testing. In this case, the IODD should be rejected by the interpreter. For the CRC, the CRC-32 method is used. The content of the IODD is being filtered during the embedding process into the CRC-algorithm (ignore ends of lines). During this process, an eventually existing stamp is removed and ends of lines are disregarded.

Reference to CRC-32: "CRC-32 algorithm used in the ISO/IEC 3309:1993 standard (withdrawn) and in section 8.1.1.6.2 of ITU-T recommendation V.42
(also check http://www.itu.int/rec/T-REC-V.42-200203-I/en).

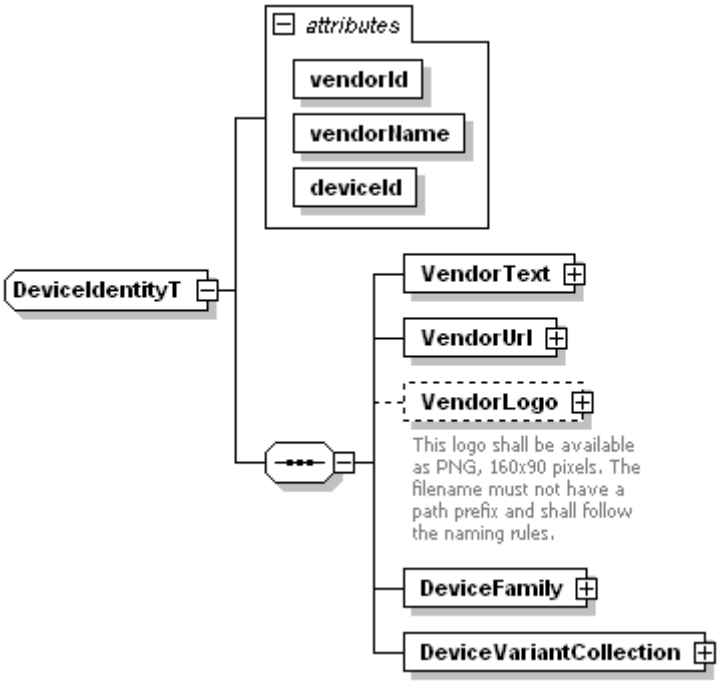
This CRC is to be found as a result in the attribute “crc”. Additionally, the checker gives its name and version. This process is used to ensure the conformity of the IODD. The “crc” may be validated by a tool.

The entry “Stamp” has to be part of the IODD. The checker then overwrites the stamp with the correct CRC, its name and version. The checker has to leap the entry “Stamp” during the formation of the CRC.

Pre-configuration of the attributes:
crc = 0
name = Empty string
version = Vx.y

Each XML-file that belongs to the IODD is being checked separately and signed.

5.2 Device identity



vendorId (m)
Text; explicit identification of the vendor worldwide; a tool has to give this id in decimal notation

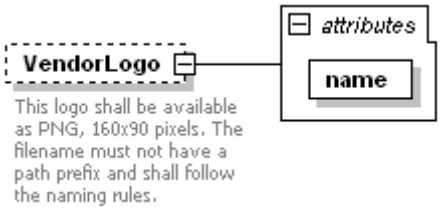
vendorName (m)
Name of the vendor of the device

deviceId (m)
Vendor-internal explicit identification of the device; a tool has to give this id in decimal notation

VendorText (m)
The vendor can use this text to describe itself

VendorUrl (m)
The vendor's URL

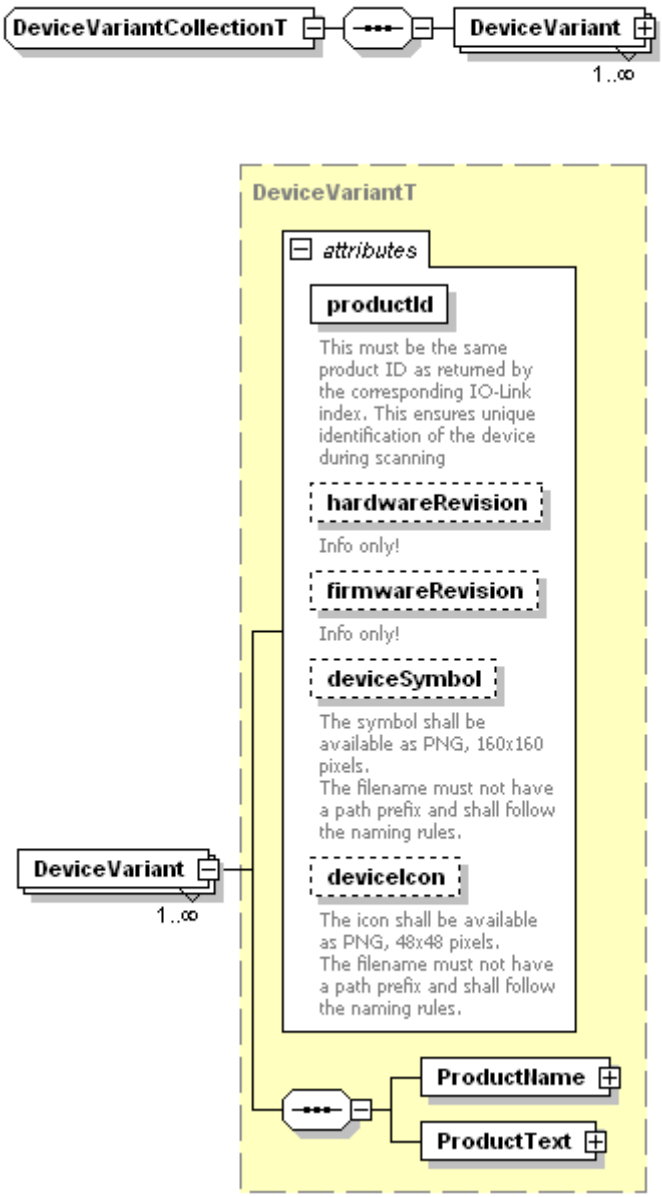
VendorLogo (o)
File name of the vendor's logo; format: .png, 160 x 90 pixels



DeviceFamily (m)
Vendor-specific classification of the devices

5.2.1 Device variants

The different device variants are listed here. There has to be at least one variant given. Variants are differed in their productId.



productId (m)
Text; explicit item number within the description file

hardwareRevision (o)
Indicates that the description file was created for this device hardware version; only informative; it does not indicate functional changes

firmwareRevision (o)
Indicates that the description file was created for this device firmware version; only informative; it does not indicate functional changes

deviceSymbol (o)
File name of the device symbol

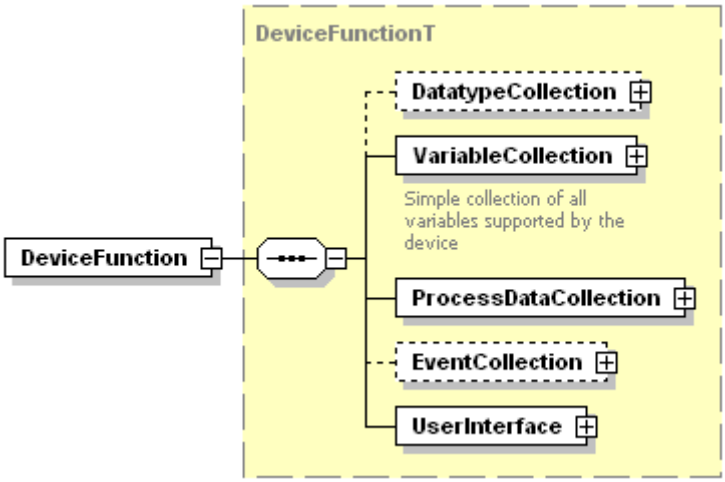
deviceIcon (o)
File name of the device icon

ProductName (m)
Text; Device name

ProductText (m)
Descriptive text of the device

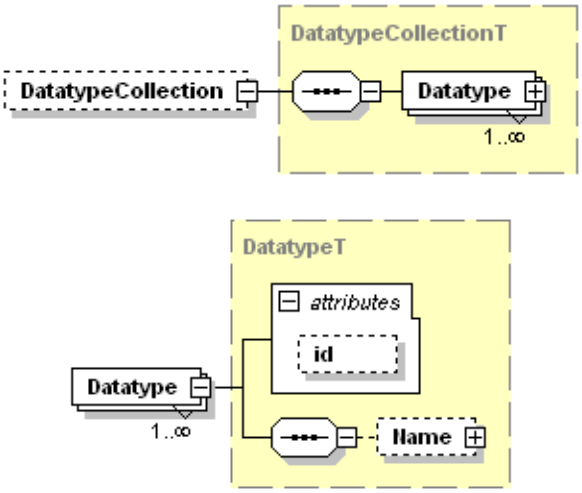
5.3 Device function

The entire functionality of the device is collected here. Parameters, process data, and events are defined. Their significances, addresses, and data fields are identified as well as a grouping of the views in menus is defined.



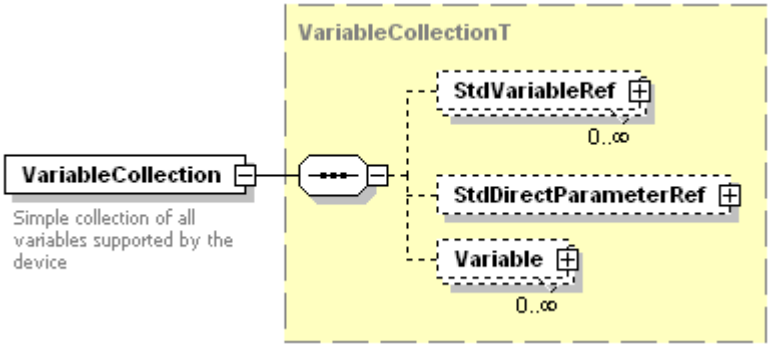
5.3.1 Declarations of data types

The DatatypeCollection incorporates all declarations for the reuse of data types (Records, Arrays). Standardized data types are described in the schema IODD-Datatypes1.0.xsd.



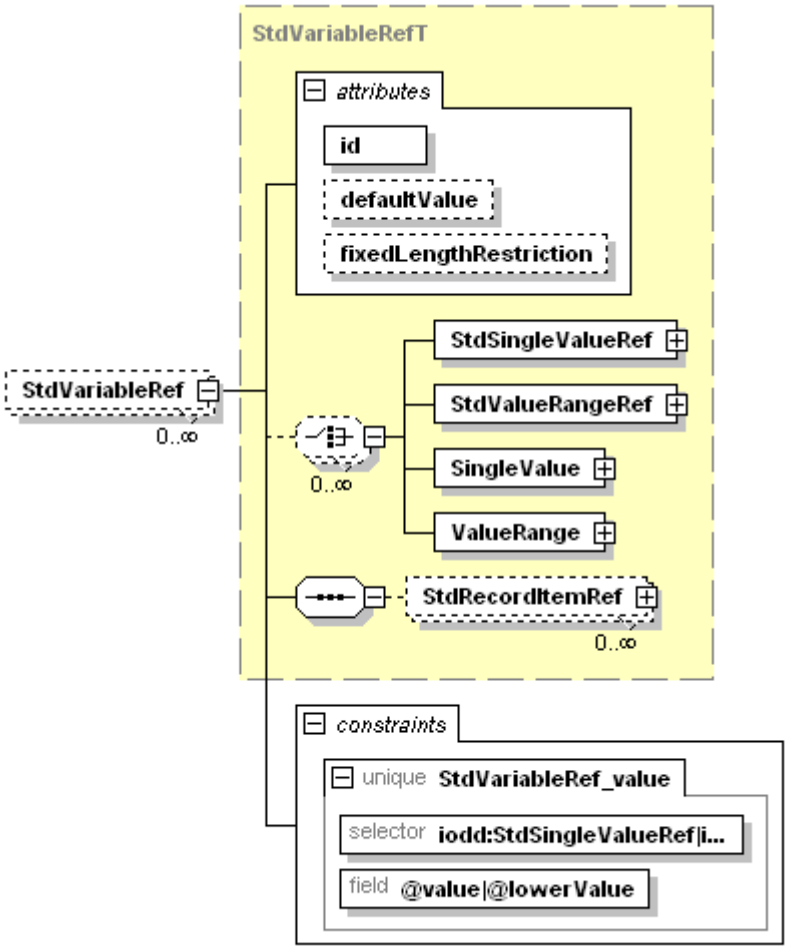
5.3.2 Variables

All parameters of the device are included here. Standard parameters are defined in IODD-StandardDefinitions1.0.xml and are referenced by StdVariableRef. Variables of the DirectParameterPage are referenced by StdDirectParameterPage. All other device-specific variables are named under “Variable”.



5.3.2.1 StdVariableRef

Here it is described, which of the standard variables are used. They are referenced here by an explicit key. If the attribute “mandatory” exists for the respective variable in the IODD-StandardDefinitions, this variable has to be referenced in the IODD. Correspondingly, the same holds for StdSingleValueRef and StdValueRangeRef.



id (m)
This id is special since it can be both starting and end point of a referencing process.

As end point of the referencing process, it contains the key of those variables within the IODD

As starting point, it references to a standard variable.

defaultValue (o)
Contains the default value of the variables

fixedLengthRestriction (o)
Contains the size limit of the variables

StdSingleValueRef (o)
Contains a reference to acceptable values the StdVariable can take on

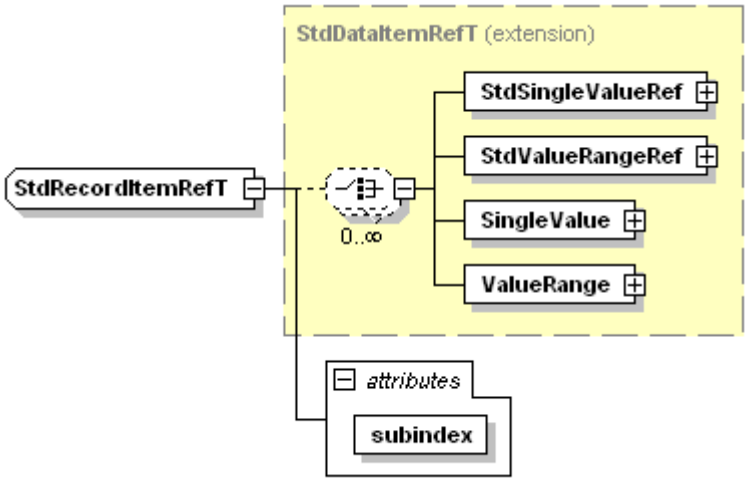
StdValueChangeRef (o)
Contains a reference to the acceptable value range of the StdVariable

SingleValue (o)
Contains acceptable values with an assigned name (for more information see “ValueRange”)

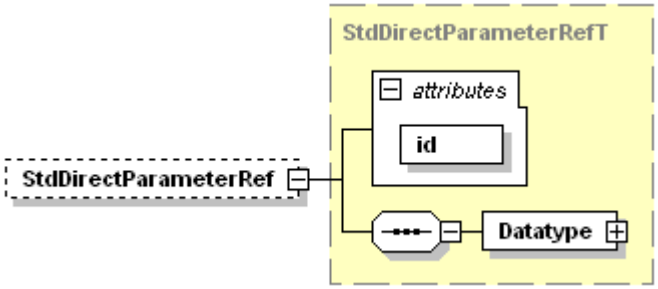
ValueRange (o)
Specification of assigned ranges with name, lowerValue, and upperValue

- For each variable, both SingleValues and ValueRanges are permitted at the same time.
- Several ValueRanges must not overlap.
- SingleValues must not be located within a ValueRange.

StdRecordItemRef (o)
Same structure as StdVariableRef; via Subindex the address within a Record can be assigned



5.3.2.2 StdDirectParameterRef



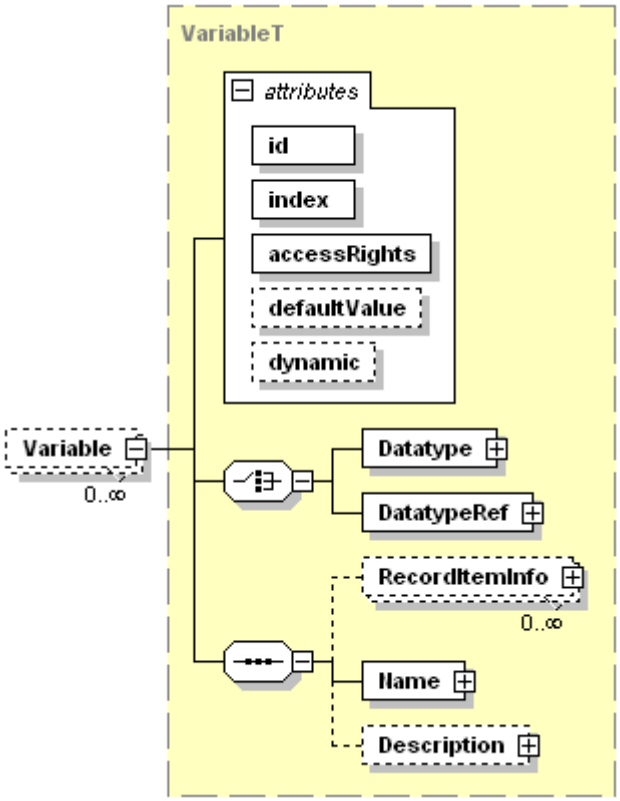
This element corresponds to the device-specific data within the DirectParameter page.

id (m)
As the end point of a referencing process, it contains the key of the variable within the IODD

Datatype (m)
Assigned data type with a maximal length of 12 byte

5.3.2.3 Variable

Contains the description of a device parameter; the data type of the variable is directly given or referenced.



id (m)
As the end point of a referencing process, it contains the key of the variable within the IODD

index (m)
Index for the addressing of a variable

accessRights (m)
“ro” read-only,
“wo”, write-only,
“rw”, read-write

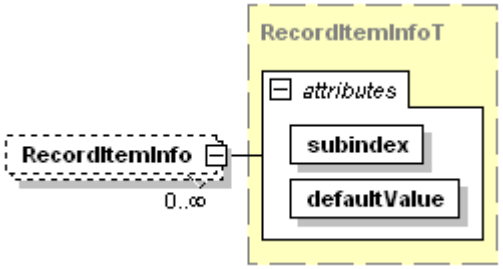
defaultValue (o)
Offline default value; it always refers to the complete variable. If the variable is a record, a separate defaultValue will be given in the associated RecordItemInfo.

dynamic (o)
Serves as information, whether the variable is autonomously changed by the device; the value range is true or false respectively

Datatype (c)
Directly given data type

DatatypeRef (c)
Reference to a data type that was defined in the declaration of data types

RecordItemInfo (o)
Contains a default value for an element of the record; the element of the record is addressed by the subindex

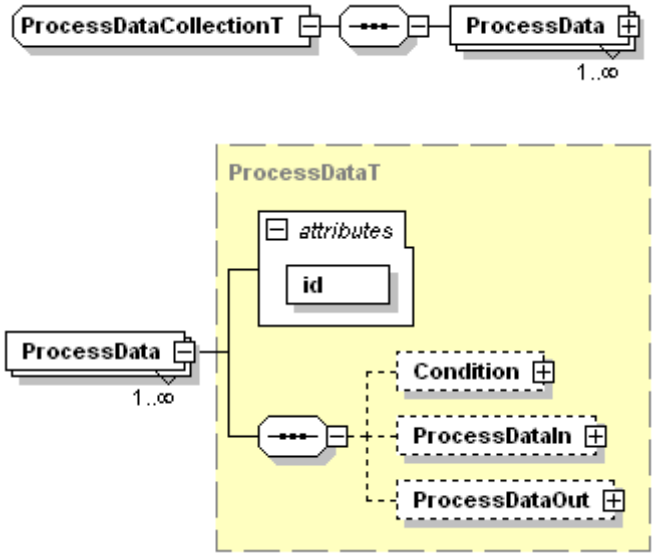


Name (m)
Contains the name of the variable

Description (o)
Contains a description of the variable (e.g. information text, help, etc.)

5.3.3 Process data

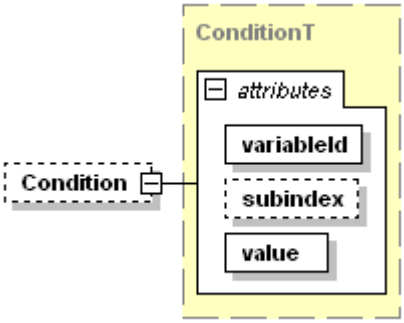
Contains all process data of the device



The element ProcessData consists of the elements Condition, ProcessDataIn, and ProcessDataOut. It can occur n times in the collection. If ProcessData occurs more than once, the individual ProcessData elements can be distinguished by to the condition element.

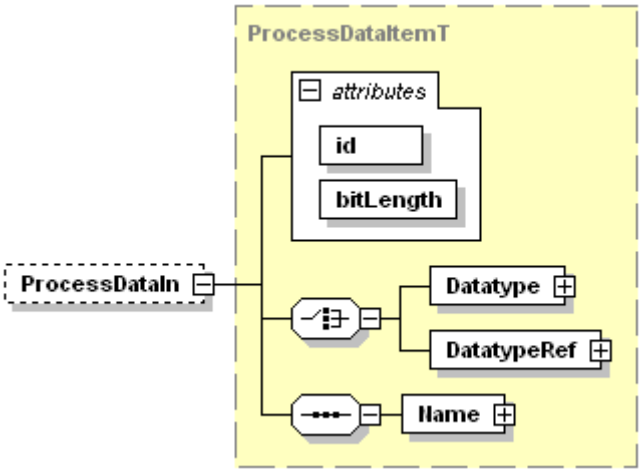
id (m)
Explicit id of the ProcessData

Condition (o):
Serves to switch between different ProcessData; Condition references the id of a variable. The assigned ProcessDataIn and ProcessDataOut descriptions are only valid if the variable takes on the value given in the attribute “value”. There shall only be exactly one variable used for the switching of process data. The referenced variable must contain a default value. The process data length (of ProcessDataIn and ProcessDataOut respectively) must be the same for all ProcessData.



ProcessDataIn(o):

Description of the input process data



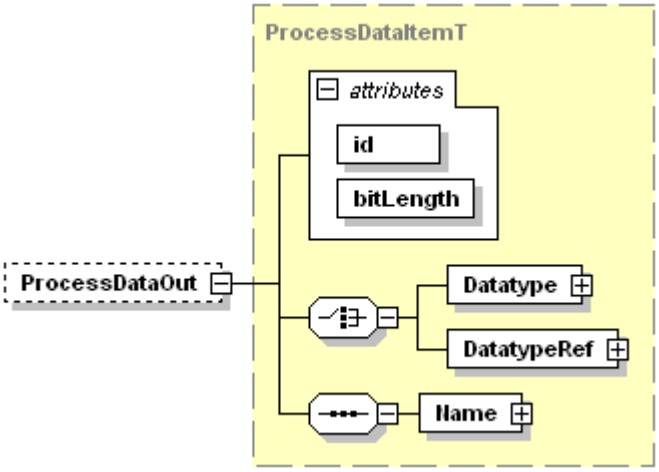
id (m)
Explicit id of the ProcessDataIn description

bitLength (m)
Length of the input process data (in bits)

Name (m)
Name specification of the input process data

ProcessDataOut(o):

Description of the output process data



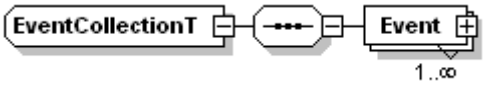
id (m)
Explicit id of the ProcessDataOut description

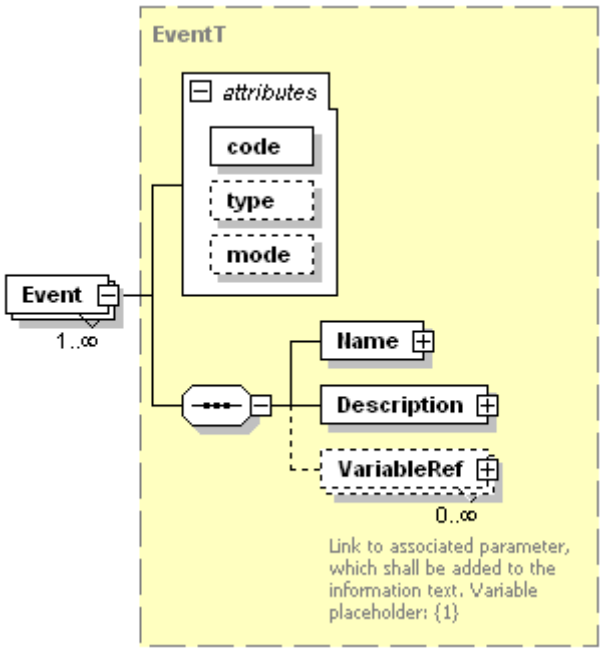
bitLength (m)
Length of the output process data (in bits)

Name (m)
Name specification of the output process data

5.3.4 Events

Contains the event collection of the device





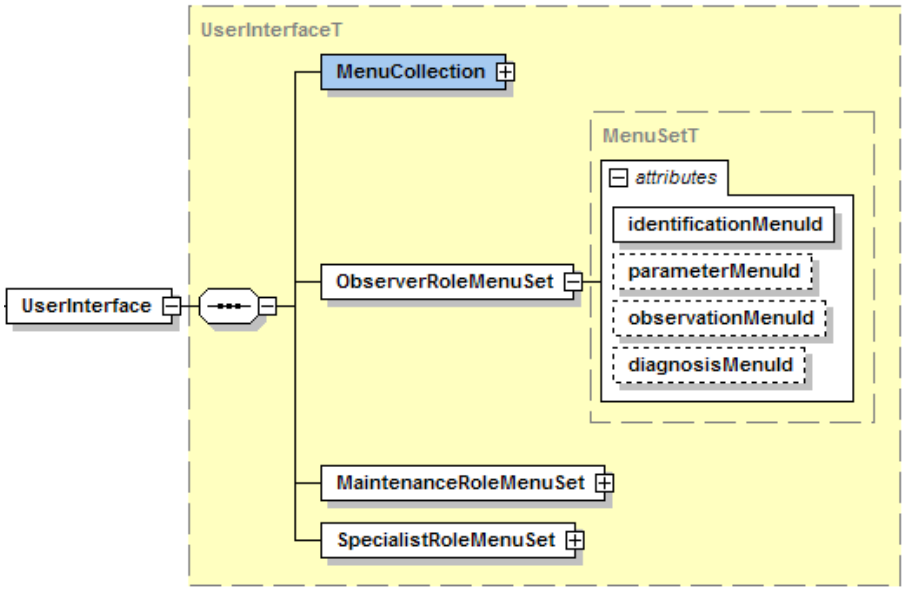
code(m), type(o) und –mode(o):
please check IO-Link-CommunicationSpecification Version 1.00 Annex B

Name(m), Description(m):
Assigned event name and event description; several placeholders for variable values may be given in the description: notation {1},{2},...{n}. The numbering of placeholders is referenced by the sequence of the denoted VariableRefs.

VariableRef(o):
Assigned variable which refers back to a replacement character of the description

5.3.5 User interface

Contains the menus of the device



Roles

A UserInterface must always be divided into three roles. It is up to the vendor how the roles are organized. The tool must assign the entered UserLevel to the respective menu. At most three menu levels below the role assignment are acceptable.

Example:

ObservationRoleMenuSet
->IdentificationMenu
-> Menu1
-> MenuRef1
-> Menu2
-> MenuRef1
MaintenanceRoleMenuSet
->ObservationMenu
-> MenuX
-> MenuRefY

ObservationRoleMenuSet(m)
This menu is designed for users who may not carry out any modifications on the device.

MaintenanceRoleMenuSet(m)
This menu is designed for observers and to undertake “uncritical” editing. It is up to the vendor to assess that.

SpecialistRoleMenuSet(m)
If the user is logged in as a specialist, he/she has total access to the device. Again, the vendor can decide which parameters may be edited.

For each role, there is a definite set of menus given. The following attributes refer back to the menu definitions of the MenuCollection.

identificationMenuId (m)
The variables which serve the identification of the device are referenced here.

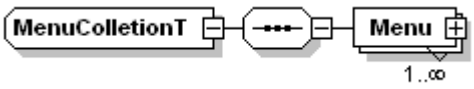
parameterMenuId (o)
The variables which serve the parameterization of the device are referenced here.

observationMenuId (o)
The variables which serve the observation of the device (process data, dynamic variables, etc.) are referenced here.

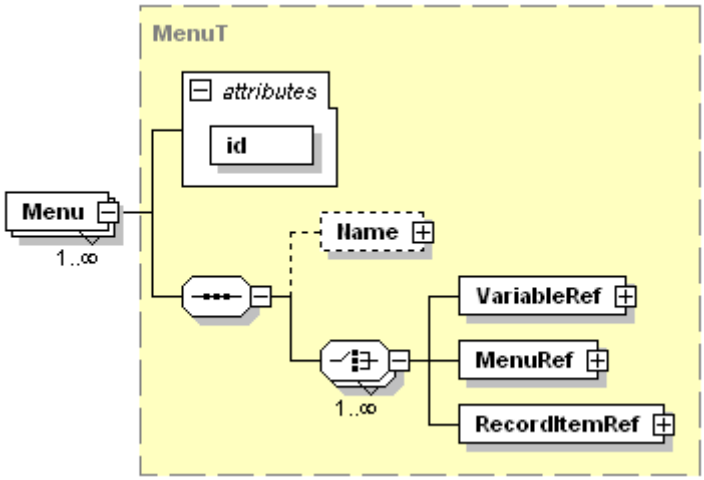
diagnosisMenuId (o)
The variables which serve the diagnosis of the device (events, etc.) are referenced here.

5.3.5.1 Menus

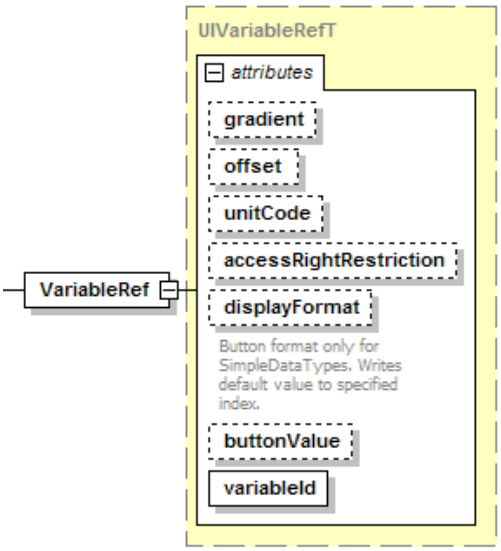
MenuCollection (m):
All menu entries of the device are collected in the MenuCollection. These menu entries may be referenced by different roles (ObserverRole, MaintenanceRole, SpecialistRole).



Menu (m)
Variables, other menus and RecordItems may be referenced here.



5.3.5.2 VariableRef



gradient (o)
Gradient of the indicated variables

offset (o)
Zero-offset of the indicated variables

unitCode (o)
Unit to which the indicated variable refers (for further information see “Coding of Units”)

accessRightRestriction (o)
For certrain UserRoles, the access rights may be limited here.

displayFormat (o)
Refers to the representation of variables; possible values are: Bin, Dec, Hex, Button, Event, MinCycleTime, MasterCycleTime. A tool or interpreter evaluates these specifications.

Definitions of the tool:

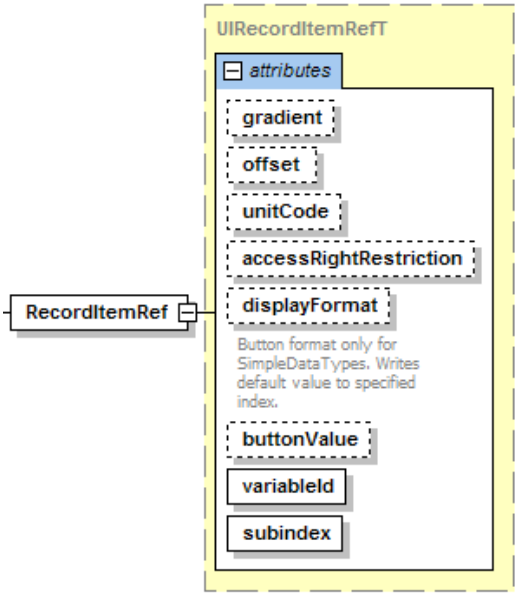
Dec: Decimal notation without postfix, e.g. 23205
Hex: Hexadecimal notation with postfix “h”, e.g. 5AA5h
Bin: Binary notation with postfix “b”, e.g. 0101 1010 1010 0101b
Button: Operation of the button sends the value of buttonValue to the device
Event: If a variable is denoted as “Event”, the value is to be interpreted as event, i.e. the respective event text is shown
MinCycleTime: The tool is able to calculate the correct time value from this byte
MasterCycleTime: The tool is able to calculate the correct time value from this byte

buttonValue (o)
If the displayFormat is “Button”, the here indicated value is sent to the device when the button is operated.

variableId (m)
Referenced variable

5.3.5.3 RecordItemRef

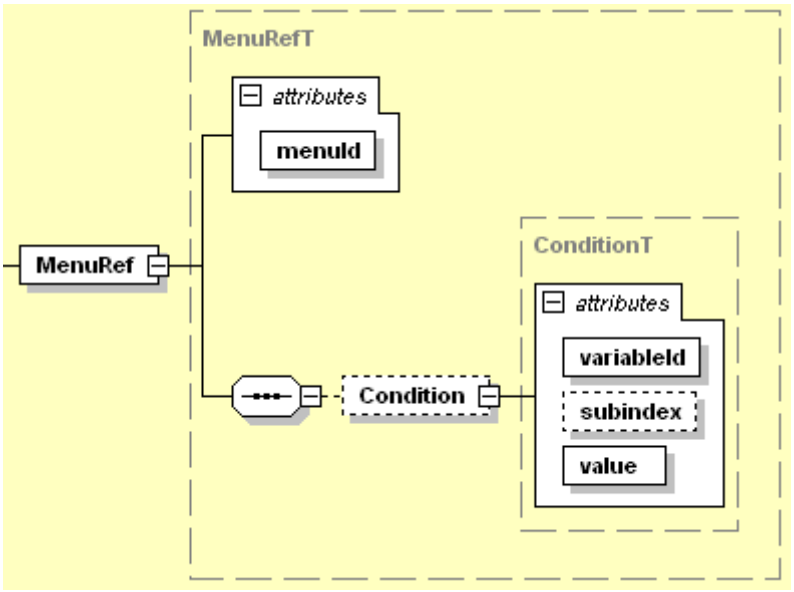
Corresponds to VariableRef with an additional subindex



subindex (m)
Referenced element of a variable of the type “Record”

5.3.5.4 MenuRef

Menus may be referenced here

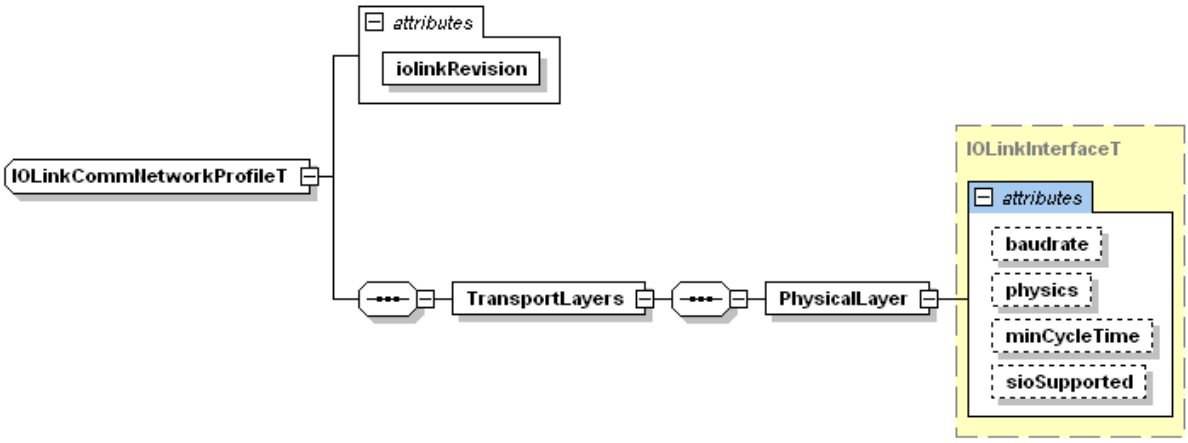


menuId (m)
Shows the menu which is to be referenced

Condition (o)
Condition for the display of this menu; a tool or interpreter only shows this menu reference if the variable with the reference *variableId* has the value *value*. If *variableId* contains a record, *subindex* must be additionally given.

5.4 Communication characteristics

Communication characteristics of an IO-Link interface are described here.



iolinkRevision (m)

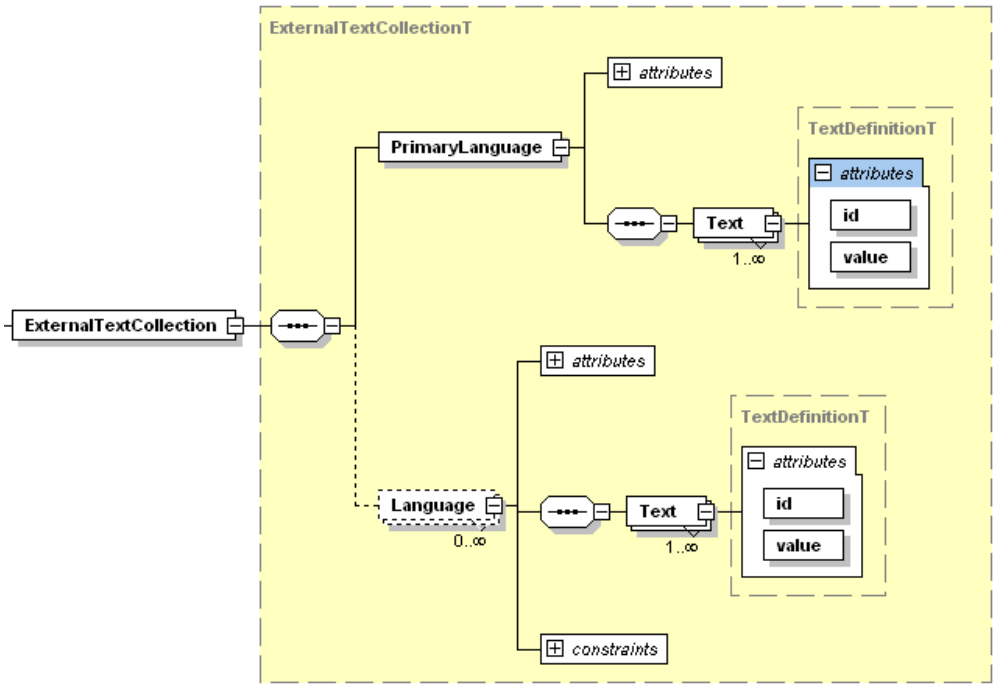
Identifies the implemented protocol version in the format “Vx.y”

PhysicalLayer (m) IOLinkInterface

baudrate (o)	COM1, COM2, COM3
physics(o)	2
minCycleTime (o)	Minimal cycle time of the slave; shown in 1 µs
sioSupported (o)	true, false

5.5 Language dependent description texts

All text components of the different languages are allocated in the ExternalTextCollection. There may be one or more languages deposited. Additional languages may be stored in proper files.

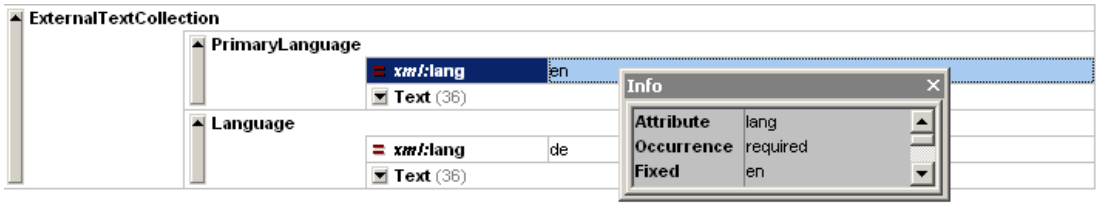


PrimaryLanguage(m)
Shall be given in English

Language(o)
Optional specification of another language

Language representation taken from ISO 639-1:2002, *Codes for the representation of names of languages – Part 1: Alpha-2 code (*see http://www.ietf.org/rfc/rfc4646.txt)

Example:



id(m):
textId; may be referenced by other elements

value(m):
text in the denoted language

6 Coding of units

Code	Unit	Display Name
1000	K	Kelvin; SI
1001	°C	degree Celsius; delta-T 1°C = delta-T 1K
1002	°F	degree Fahrenheit
1003	°R	degree Rankine
1004	r	radian; 1 r = 1 m/m = 1
1005	°	degree; 1° = (p/180)rad
1006	'	minute; 1' = (1°/60)
1007	''	second; 1'' = (1'/60)
1008	gon	gon (or grade); 1 gon = (p/200)rad
1009	rev	revolution
1010	m	Meter; SI
1011	km	Kilometer
1012	cm	Centimeter
1013	mm	Millimeter
1014	µm	Micrometer
1015	nm	Nanometer
1016	pm	Picometer
1017	æ	Angstrom; 1 æ = 10-10m
1018	ft	feet
1019	in	inch
1020	yd	yard
1021	Mile	1 Mile = 1609 m
1022	Nautical mile	Nautical mile; 1 nautical mile = 1852 meters
1023	m^2	Square meter
1024	km^2	Square kilometer
1025	cm^2	Square centimeter
1026	dm^2	square decimeter
1027	mm^2	Square millimeter
1028	a	are; 1 a = 10^2 m^2
1029	ha	Hectare; 1 ha = 104 m^2
1030	in^2	Square inch
1031	ft^2	Square feet
1032	yd^2	Square yard
1033	$mile^2$	Square mile
1034	m^3	Cubic meter
1035	dm^3	Cubic decimeter
1036	cm^3	Cubic centimeter
1037	mm^3	Cubic millimeter
1038	L	Liters; 1 L = 10^{-3} m^3
1039	cl	Centiliter
1040	ml	Milliliter
1041	hl	Hectoliter
1042	in^3	Cubic inch
1043	ft^3	Cubic feet
1044	yd^3	Cubic yard

Code	Unit	Display Name
1045	mile³	Cubic mile
1046	pint	Pint
1047	quart	Quart
1048	gallon	US gallon
1049	ImpGal	Imperial gallon
1050	bushel	Bushel
1051	bbl	barrel; 1 bbl = 42 US gallons
1052	bbl (liq)	Barrel liquid; 1 liquid bbl = 31.5 US gallons
1053	SCF	Standard cubic foot
1054	s	Second; SI
1055	ks	Kilosecond
1056	ms	millisecond
1057	µs	Microsecond
1058	min	Minute; 1 min = 60 s
1059	h	Hour; 1 h = 60 min
1060	d	Day; 1 d = 24 h
1061	m/s	Meter per second
1062	mm/s	Millimeter per second
1063	m/h	meter per hour
1064	km/h	Kilometer per hour
1065	knot	Knot; 1 knot = 1.852 km/h
1066	in/s	Inch per second
1067	ft/s	Feet per second
1068	yd/s	yard per second
1069	in/min	Inch per minute
1070	ft/min	Feet per minute
1071	yd/min	Yard per minute
1072	in/h	Inch per hour
1073	ft/h	Feet per hour
1074	yd/h	Yard per hour
1075	MPH	Miles per hour
1076	m/s²	Meter per second per second (acceleration)
1077	Hz	Hertz; 1 Hz = 1 s-1
1078	THz	Terahertz
1079	GHz	Gigahertz
1080	MHz	Megahertz
1081	kHz	Kilohertz
1082	1/s	Per second
1083	1/min	Per minute
1084	Rev/s	Revolutions per second
1085	RPM	Revolutions per minute
1086	r/s	Radian per second
1087	1/s²	Per second per second
1088	kg	Kilogram; SI
1089	g	Gram
1090	mg	Milligram
1091	Mg	Megagram

Code	Unit	Display Name
1092	t	Metric ton; 1 t = 10^3kg
1093	oz	Ounce
1094	lb	Pound (mass)
1095	STon	Short ton; 1 short ton = 2000 pounds
1096	LTon	Long ton; 1 long ton = 2240 pounds
1097	kg/m³	Kilograms per cubic meter
1098	Mg/m³	Megagrams per cubic meter
1099	kg/dm³	Kilograms per cubic decimeter
1100	g/cm³	Grams per cubic centimeter
1101	g/m³	Grams per cubic meter
1102	t/m³	Metric tons per cubic meter
1103	kg/L	Kilograms per liter
1104	g/ml	Grams per milliliter
1105	g/L	Grams per liter
1106	lb/in³	Pounds per cubic inch
1107	lb/ft³	Pounds per cubic foot
1108	lb/gal	Pounds per US gallon
1109	STon/yd³	Short tons per cubic yard; 1 STon = 2000 pounds
1110	degTwad	Degrees Twaddell
1111	degBaum hv	Degrees Baume heavy
1112	degBaum lt	Degrees Baume light
1113	degAPI	Degrees API
1114	SGU	Specific gravity units
1115	kg/m	Kilograms per meter
1116	mg/m	Milligrams per meter
1117	tex	Tex; 1 tex = 10-6kg/m = 1 g/km
1118	kg/m²	Kilogram per square meter
1119	kg m/s	Kilogram meter per second
1120	N	Newton; 1 N = 1 kg m/s²
1121	MN	Meganewton
1122	kN	Kilonewton
1123	mN	Millinewton
1124	µN	Micronewton
1125	kg-m²/s	Kilogram square meter per second
1126	Nm	Newton meter
1127	MNm	Meganewton meter
1128	kNm	Kilonewton meter
1129	mNm	Millinewton meter
1130	Pa	Pascal; 1 Pa = 1 N/m²
1131	GPa	Gigapascal
1132	MPa	Megapascal
1133	kPa	Kilopascal
1134	mPa	Millipascal
1135	µPa	Micropascal
1136	hPa	Hectopascal
1137	bar	bar; 1 bar = 100 kPa
1138	mbar	Millibar; 1 mbar = 1 hPa

Code	Unit	Display Name
1139	torr	Torr; 1 Torr = 1 mmHg at 0 °C and 1 g
1140	atm	Atmospheres
1141	psi	Pounds per square inch; unreferenced or differential pressure
1142	psia	Pounds per square inch absolute; referenced to a vacuum
1143	psig	Pounds per square inch guage; referenced to atmosphere
1144	g/cm²	Gram per square centimeter
1145	kg/cm²	Kilogram per square centimeter
1146	inH2O	Inches of water
1147	inH2O (4°C)	Inches of water at 4°C
1148	inH2O (68°F)	Inches of water at 68°F
1149	mmH2O	Millimeters of water
1150	mmH2O (4°C)	Millimeters of water at 4°C
1151	mmH2O (68°F)	Millimeters of water at 68°F
1152	ftH2O	Feet of water
1153	ftH2O (4°C)	Feet of water at 4°C
1154	ftH2O (68°F)	Feet of water at 68°F
1155	inHg	Inches of mercury
1156	inHg (0°C)	Inches of mercury at 0°C
1157	mmHg	Millimeters of mercury
1158	mmHg (0°C)	Millimeters of mercury at 0°C
1159	Pa-s	Pascal second
1160	m²/s	square meter per second
1161	P	Poise
1162	cP	Centipoise; 1 cP = 1 mPa-s
1163	St	Stokes
1164	cSt	Centistokes; 1 cSt = 1 mm²/s
1165	N/m	Newton per meter
1166	mN/m	Millinewton per meter
1167	J	Joule; 1 J = 1 N-m
1168	EJ	Exajoules
1169	PJ	Petajoules
1170	TJ	Terajoules
1171	GJ	Gigajoules
1172	MJ	Megajoules
1173	kJ	Kilojoules
1174	mJ	Millijoules
1175	WH	Watt hour; 1 W-h = 3.6 kJ
1176	TWH	Terawatt hour
1177	GWH	Gigawatt hour
1178	MWH	Megawatt hour
1179	KWH	Kilowatt hour
1180	cal	Calorie; 1 cal = 4.184 J
1181	kcal	Kilocalorie
1182	Mcal	Megacalorie
1183	Btu	British thermal unit; 1 Btu = 0.2519958 kcal
1184	decatherm	Dekatherm; 1 decatherm = 10^5 BTU

Code	Unit	Display Name
1185	ft-lb	Foot-pound
1186	W	Watt; 1 W = 1 J/s
1187	TW	Terawatt
1188	GW	Gigawatt
1189	MW	Megawatt
1190	KW	Kilowatt
1191	mW	Milliwatt
1192	µW	Microwatt
1193	nW	Nanowatt
1194	pW	Picowatt
1195	Mcal/h	Megacalorie per hour
1196	MJ/h	Megajoule per hour
1197	Btu/h	British thermal unit per hour
1198	hp	Horsepower
1199	W/(m-K)	Watt per meter kelvin
1200	W/(m²-K)	Watt per square meter kelvin
1201	m²-K/W	Square meter kelvin per watt
1202	J/K	Joule per kelvin
1203	kJ/K	Kilojoule per kelvin
1204	J/(kg-K)	Joule per kilogram kelvin
1205	kJ/(kg-K)	Kilojoule per kilogram kelvin
1206	J/kg	Joule per kilogram
1207	MJ/kg	Megajoule per kilogram
1208	kJ/kg	Kilojoule per kilogram
1209	A	Ampere; SI
1210	kA	Kiloampere
1211	mA	Milliampere
1212	µA	Microampere
1213	nA	Nanoampere
1214	pA	Picoampere
1215	C	Coulomb; 1 C = 1 A-s
1216	MC	Megacoulomb
1217	kC	Kilocoulomb
1218	µC	Microcoulomb
1219	nC	Nanocoulomb
1220	pC	Picocoulomb
1221	Ah	Ampere hour; 1 Ah = 3.6 kC
1222	C/m³	Coulomb per cubic meter
1223	C/mm³	Coulomb per cubic millimeter
1224	C/cm³	Coulomb per cubic centimeter
1225	kC/m³	Kilocoulomb per cubic meter
1226	mC/m³	Millicoulomb per cubic meter
1227	µC/m³	Microcoulomb per cubic meter
1228	C/m²	Coulomb per square meter
1229	C/mm²	Coulomb per square millimeter
1230	C/cm²	Coulomb per square centimeter
1231	kC/m²	Kilocoulomb per square meter
1232	mC/m²	Millicoulomb per square meter

Code	Unit	Display Name
1233	µC/m²	Microcoulomb per square meter
1234	V/m	Volt per meter
1235	MV/m	Megavolt per meter
1236	KV/m	Kilovolt per meter
1237	V/cm	Volt per centimeter
1238	mV/m	Millivolt per meter
1239	µV/m	Microvolt per meter
1240	V	Volt; 1 V = 1 W/A
1241	MV	Megavolt
1242	KV	Kilovolt
1243	mV	Millivolt
1244	µV	Microvolt
1245	F	Farad; 1 F = 1 C/V
1246	mF	Millifarad
1247	µF	Microfarad
1248	nF	Nanofarad
1249	pF	Picofarad
1250	F/m	Farad per meter
1251	µF/m	Microfarad per meter
1252	nF/m	Nanofarad per meter
1253	pF/m	Picofarad per meter
1254	C-m	Coulomb meter
1255	A/m²	Ampere per square meter
1256	MA/m²	Megampere per square meter
1257	A/cm²	Ampere per square centimeter
1258	kA/m²	Kiloampere per square meter
1259	A/m	Ampere per meter
1260	KA/m	Kiloampere per meter
1261	A/cm	Ampere per centimeter
1262	T	Tesla; 1 T = 1 Wb/m²
1263	mT	Millitesla
1264	µT	Microtesla
1265	nT	Nanotesla
1266	Wb	Weber; 1 Wb = 1 V-s
1267	mWb	Milliweber
1268	Wb/m	Weber per meter
1269	KWb/m	Kiloweber per meter
1270	H	Henry; 1 H = 1 Wb/A
1271	mH	Millihenry
1272	µH	Microhenry
1273	nH	Nanohenry
1274	pH	Picohenry
1275	H/m	Henry per meter
1276	µH/m	Microhenry per meter
1277	nH/m	Nanohenry per meter
1278	Am²	Ampere square meter
1279	Nm²/A	Newton square meter per ampere
1280	Wb-m	Weber meter

Code	Unit	Display Name
1281	Ohm	Ohm; 1 W = 1 V/A
1282	GOhm	GigaOhm
1283	MOhm	Megaohm
1284	kOhm	Kiloohm
1285	mOhm	Milliohm
1286	µOhm	Microohm
1287	S	Siemens; 1 S = 1 W-1
1288	kS	Kilosiemens
1289	mS	Millisiemens
1290	µS	Microsiemens
1291	Ohm-m	Ohm meter
1292	GOhm-m	GigaOhm meter
1293	MOhm-m	MegaOhm meter
1294	kOhm-m	Kiloohm meter
1295	Ohm-cm	Ohm centimeter
1296	mOhm-m	Milliohm meter
1297	µOhm m	Microohm meter
1298	nOhm m	Nanoohm meter
1299	S/m	Siemens per meter
1300	MS/m	Megasiemens per meter
1301	kS/m	Kilosiemens per meter
1302	mS/cm	Millisiemens per centimeter
1303	mS/mm	Microsiemens per millimeter
1304	1/H	Per henry
1305	sr	Steradian; 1 sr = 1 m²/m² = 1
1306	W/sr	Watt per steradian
1307	W/(sr-m²)	Watt per steradian square meter
1308	W/(m²)	Watt per square meter
1309	lm	Lumen; 1 lm = 1 cd-sr
1310	lm-s	Lumen second
1311	lm-h	Lumen hour; 1 lm-h = 3600 lm-s
1312	lm/m²	Lumen per square meter
1313	lm/W	Lumen per watt
1314	lx	Lux; 1 lx = 1 lm/m²
1315	lx-s	Lux second
1316	cd	Candela; SI
1317	cd/m²	Candela per square meter
1318	g/s	Gram per second
1319	g/min	Gram per minute
1320	g/h	Gram per hour
1321	g/d	Gram per day
1322	kg/s	Kilogram per second
1323	kg/min	Kilogram per minute
1324	kg/h	Kilogram per hour
1325	kg/d	Kilogram per day
1326	t/s	Metric ton per second; 1 t = 1000 kg
1327	t/min	Metric ton per minute; 1 t = 1000 kg
1328	t/h	Metric ton per hour; 1 t = 1000 kg

Code	Unit	Display Name
1329	t/d	Metric ton per day
1330	lb/s	Pound per second
1331	lb/min	Pound per minute
1332	lb/h	Pound per hour
1333	lb/d	Pound per day
1334	STon/s	Short ton per second; 1 STon = 2000 pounds
1335	STon/min	Short ton per minute
1336	STon/h	Short ton per hour
1337	STon/d	Short ton per day
1338	LTon/s	Long ton per second; 1 LTon = 2240 pounds
1339	LTon/min	Long ton per minute
1340	LTon/h	Long ton per hour
1341	LTon/d	Long ton per day
1342	%	Percent
1343	% sol/wt	Percent solids per weight
1344	% sol/vol	Percent solids per volume
1345	% stm qual	Percent steam quality
1346	% plato	Percent plato
1347	m^3/s	Cubic meter per second
1348	m^3/min	Cubic meter per minute
1349	m^3/h	Cubic meter per hour
1350	m^3/d	Cubic meter per day
1351	L/s	Liter per second
1352	L/min	Liter per minute
1353	L/h	Liter per hour
1354	L/d	Liter per day
1355	ML/d	Megaliter per day
1356	CFS	Cubic feet per second
1357	CFM	Cubic feet per minute
1358	CFH	Cubic feet per hour
1359	ft^3/d	Cubic feet per day
1360	SCFM	Standard cubic feet per minute
1361	SCFH	Standard cubic feet per hour
1362	gal/s	US gallon per second
1363	GPM	US gallon per minute
1364	gal/h	US gallon per hour
1365	gal/d	US gallon per day
1366	Mgal/d	Mega US gallon per day
1367	ImpGal/s	Imperial gallon per second
1368	ImpGal/min	Imperial gallon per minute
1369	ImpGal/h	Imperial gallon per hour
1370	ImpGal/d	Imperial gallon per day
1371	bbl/s	Barrel per second; 1 bbl = 42 US gallons
1372	bbl/min	Barrel per minute
1373	bbl/h	Barrel per hour
1374	bbl/d	Barrel per day
1375	W/m^2	Watt per square meter
1376	mW/m^2	Milliwatt per square meter

Code	Unit	Display Name
1377	µW/m²	Microwatt per square meter
1378	pW/m²	Picowatt per square meter
1379	Pa-s/m³	Pascal second per cubic meter
1380	N-s/m	Newton second per meter
1381	Pa-s/m	Pascal second per meter
1382	B	Bel
1383	dB	decibel; 1 dB = 10-1B
1384	mol	Mole; SI
1385	kmol	kilomole
1386	mmol	Millimole
1387	µmol	Micromole
1388	kg/mol	Kilogram per mole
1389	g/mol	Gram per mole
1390	m³/mol	Cubic meter per mole
1391	dm³/mol	Cubic decimeter per mole
1392	cm³/mol	Cubic centimeter per mole
1393	L/mol	Liters per mole
1394	J/mol	Joule per mole
1395	kJ/mol	Kilojoule per mole
1396	J/(mol-K)	Joule per mole kelvin
1397	mol/m³	Mole per cubic meter
1398	mol/dm³	Mole per cubic decimeter
1399	mol/L	Mole per liter
1400	mol/kg	Mole per kilogram
1401	mmol/kg	Millimole per kilogram
1402	Bq	Becquerel; 1 Bq = 1-s-1
1403	MBq	Megabecquerel
1404	kBq	Kilobequerel
1405	Bq/kg	Becquerel per kilogram
1406	kBq/kg	Kilobecquerel per kilogram
1407	MBq/kg	Megabecquerel per kilogram
1408	Gy	Gray; 1 Gy = 1 J/kg
1409	mGy	Milligray
1410	rad	Rad; 1 rad = 10-² Gy
1411	Sv	Sievert; 1 Sv = 1 J/kg
1412	mSv	Millisievert
1413	rem	Rem; 1 rem = 10-² Sv
1414	C/kg	Coulomb per kilogram
1415	mC/kg	Millicoulomb per kilogram
1416	R	Röntgen; 1 R = 2.58 x 10-4 C/kg
1417	1/J-m³	1 per Joule and cubic metre
1418	e/V-m³	electron volt per cubic metre
1419	m³/C	Cubic meter per coulomb
1420	V/K	Volt per kelvin
1421	mV/K	Millivolt per kelvin
1422	pH	PH-Value
1423	ppm	Parts per million
1424	ppb	Parts per billion

Code	Unit	Display Name
1425	ppt	Parts per thousand
1426	degBrix	Degrees Brix
1427	degBall	Degrees Balling
1428	proof/vol	Proof per volume
1429	proof/mass	Proof per mass
1430	lb/ImpGal	Pound per Imperial gallon
1431	kcal/s	Kilocalorie per second
1432	kcal/min	Kilocalorie per minute
1433	kcal/h	Kilocalorie per hour
1434	kcal/d	Kilocalorie per day
1435	Mcal/s	Megacalorie per second
1436	Mcal/min	Megacalorie per minute
1437	Mcal/d	Megacalorie per day
1438	kJ/s	Kilojoules per second
1439	kJ/min	Kilojoules per minute
1440	kJ/h	Kilojoules per hour
1441	kJ/d	Kilojoules per day
1442	MJ/s	Megajoules per second
1443	MJ/min	Megajoules per minute
1444	MJ/d	Megajoules per day
1445	Btu/s	British thermal units per second
1446	Btu/min	British thermal units per minute
1447	Btu/day	British thermal units per day
1448	µgal/s	Micro US gallon per second
1449	mgal/s	Milli US gallon per second
1450	kgal/s	Kilo US gallon per second
1451	Mgal/s	Mega US gallon per second
1452	µgal/min	Micro US gallon per minute
1453	mgal/min	Milli US gallon per second
1454	kgal/min	Kilo US gallon per minute
1455	Mgal/min	Mega US gallon per minute
1456	µgal/h	Micro US gallon per hour
1457	mgal/h	Milli US gallon per hour
1458	kgal/h	Kilo US gallon per hour
1459	Mgal/h	Mega US gallon per hour
1460	µgal/d	Micro US gallon per day
1461	mgal/d	Milli US gallon per day
1462	kgal/d	Kilo US gallon per day
1463	µImpGal/s	Micro imperial gallon per second
1464	mImpGal/s	Milli imperial gallon per second
1465	KImpGal/s	Kilo imperial gallon per second
1466	MImpGal/s	Mega imperial gallon per second
1467	µImpGal/min	Micro imperial gallon per minute
1468	mImpGal/min	Milli imperial gallon per minute
1469	kImpGal/min	Kilo imperial gallon per minute
1470	MImpGal/min	Mega imperial gallon per minute
1471	µImpGal/h	Micro imperial gallon per hour
1472	mImpGal/h	Milli imperial gallon per hour

Code	Unit	Display Name
1473	kImpGal/h	Kilo imperial gallon per hour
1474	MImpGal/h	Mega imperial gallon per hour
1475	µImpGal/d	Micro imperial gallon per day
1476	mImpGal/d	Milli imperial gallon per day
1477	kImpGal/d	Kilo imperial gallon per day
1478	MImpGal/d	Mega imperial gallon per day
1479	µbbl/s	Microbarrel per second
1480	mbbl/s	Millibarrel per second
1481	kbbl/s	Kilobarrel per second
1482	Mbbl/s	Megabarrel per second
1483	µbbl/min	Microbarrel per minute
1484	mbbl/min	Millibarrel per minute
1485	kbbl/min	Kilobarrel per minute
1486	Mbbl/min	Megabarrel per minute
1487	µbbl/h	Microbarrel per hour
1488	mbbl/h	Millibarrel per hour
1489	kbbl/h	Kilobarrel per hour
1490	Mbbl/h	Megabarrel per hour
1491	µbbl/d	Microbarrel per day
1492	mbbl/d	Millibarrel per day
1493	kbbl/d	Kilobarrel per day
1494	Mbbl/d	Megabarrel per day
1495	µm³/s	Cubic micrometer per second
1496	mm³/s	Cubic millimeter per second
1497	km³/s	Cubic kilometer per second
1498	Mm³/s	Cubic megameter per second
1499	µm³/min	Cubic micrometer per minute
1500	mm³/min	Cubic millimeter per minute
1501	km³/min	Cubic kilometer per minute
1502	Mm³/min	Cubic megameter per minute
1503	µm³/h	Cubic micrometer per hour
1504	mm³/h	Cubic millimeter per hour
1505	km³/h	Cubic kilometer per hour
1506	Mm³/h	Cubic megameter per hour
1507	µm³/d	Cubic micrometer per day
1508	mm³/d	Cubic millimeter per day
1509	km³/d	Cubic kilometer per day
1510	Mm³/d	Cubic megameter per day
1511	cm³/s	Cubic centimeter per second
1512	cm³/min	Cubic centimeter per minute
1513	cm³/h	Cubic centimeter per hour
1514	cm³/d	Cubic centimeter per day
1515	kcal/kg	Kilocalorie per kilogram
1516	Btu/lb	British thermal unit per pound
1517	kL	Kiloliter
1518	kL/min	Kiloliter per minute
1519	kL/h	Kiloliter per hour
1520	kL/d	Kiloliter per day

Code	Unit	Display Name
1551	S/cm	Siemens per centimeter
1552	µS/cm	Micro Siemens per centimeter
1553	mS/m	Milli Siemens per meter
1554	µS/m	Micro Siemens per meter
1555	MOHM*cm	Mega Ohm times centimeter
1556	kOHM*cm	Kilo Ohm times centimeter
1557	Gew%	Percent of weight
1558	mg/l	Milligram per liter
1559	µg/l	Microgram per Liter
1560	%Sät	Percent saturation
1561	vpm	vpm
1562	%vol	Volume percent
1563	mL/min	Milliliter per minute
1564	mg/dm3	Milligram per cubic decimeter
1565	mg/l	Milligram per Liter
1566	mg/m³	Milligram per cubic meter

Annex A IODD schemas

The following schemas are part of this specification and are enclosed in the IO-Link schema container **IOL-Device-Description-Schemas_V10_090118.zip**:

- IODD1.0.xsd
- IODD-Primitives1.0.xsd
- IODD-Datatypes1.0.xsd
- IODD-Variables1.0.xsd
- IODD-Menus1.0.xsd
- IODD-Communication1.0.xsd
- IO-StandardDefinitions1.0.xsd
- IO-StandardDefinitions1.0.xml

Annex B Errata for IODD specification V1.0 dated September 2008

B.1 Clause 5.5

Special characters shall be coded according to the XML-Syntax:

& → &

’ → '

> → >

< → <

“ → &quot

LF → &#10 ; LF = linefeed

Only the linefeed is allowed for formatting the text.

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