

Communication networks and systems in substations —

Part 7-3: Basic communication structure for substation and feeder equipment — Common data classes

The European Standard EN 61850-7-3:2003 has the status of a
British Standard

ICS 33.200

National foreword

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The UK participation in its preparation was entrusted to Technical Committee PEL/57, Power systems control, which has the responsibility to:

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Part 7-3: Basic communication structure
for substation and feeder equipment –
Common data classes
(IEC 61850-7-3:2003)

Réseaux et systèmes de communication
dans les postes
Partie 7-3: Structure des communications
de base pour les postes électriques
et les équipements de lignes –
Classes de données communes
(CEI 61850-7-3:2003)

Kommunikationsnetze und -systeme
in Stationen
Teil 7-3: Grundlegende
Kommunikationsstruktur für stations-
und feldbezogene Ausrüstung -
Gemeinsame Datenklassen
(IEC 61850-7-3:2003)

This European Standard was approved by CENELEC on 2003-05-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

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Annexes designated "normative" are part of the body of the standard.

Annexes designated "informative" are given for information only.

In this standard, annexes A and ZA are normative and annex B is informative.

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 61850-7-3:2003 was approved by CENELEC as a European Standard without any modification.

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INTRODUCTION

This document is part of a set of specifications, which details layered substation communication architecture. This architecture has been chosen to provide abstract definitions of classes and services such that the specifications are independent of specific protocol stacks and objects. The mapping of these abstract classes and services to communication stacks is outside the scope of IEC 61850-7-x and may be found in IEC 61850-8-x (station bus) and IEC 61850-9-x (process bus).

IEC 61850-7-1 gives an overview of this communication architecture. This part of IEC 61850 defines common attribute types and common data classes related to substation applications. These common data classes are used in IEC 61850-7-4. To define compatible data classes, the attributes of the instances of data shall be accessed using services defined in IEC 61850-7-2.

This part is used to specify the **abstract common data class** definitions. These abstract definitions shall be mapped into concrete object definitions that are to be used for a particular protocol (for example MMS, ISO 9506).

COMMUNICATION NETWORKS AND SYSTEMS IN SUBSTATIONS –

Part 7-3: Basic communication structure for substation and feeder equipment – Common data classes

1 Scope

This part of IEC 61850 specifies common attribute types and common data classes related to substation applications. In particular it specifies:

- common data classes for **status information**,
- common data classes for **measured information**,
- common data classes for **controllable status information**,
- common data classes for **controllable analogue set point information**,
- common data classes for **status settings**,
- common data classes for **analogue settings** and
- **attribute types** used in these common data classes.

This international standard is applicable to the description of device models and functions of substations and feeder equipment.

This international standard may also be applied, for example, to describe device models and functions for:

- substation to substation information exchange,
- substation to control centre information exchange,
- power plant to control centre information exchange,
- information exchange for distributed generation, or
- information exchange for metering.

2 Normative references

The following referenced documents are indispensable for the application 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 61850-2, *Communication networks and systems in substations – Part 2: Glossary* ¹

IEC 61850-7-1, *Communication networks and systems in substations – Part 7-1: Basic communication structure for substation and feeder equipment – Principles and models*

IEC 61850-7-2, *Communication networks and systems in substations – Part 7-2: Basic communication structure for substation and feeder equipment – Abstract communication service interface (ACSI)*

IEC 61850-7-4, *Communication networks and systems in substations – Part 7-4: Basic communication structure for substation and feeder equipment – Compatible logical node classes and data classes*

ISO 1000, *SI units and recommendations for the use of their multiples and of certain other units*

¹ Under consideration.

3 Terms and definitions

For the purposes of this International Standard, the terms and definitions given in IEC 61850-2² and 61850-7-2 apply.

4 Abbreviated terms

CDC	Common Data Class
dchg	Trigger option for data-change
dupd	Trigger option for data-update
FC	Functional Constraint
qchg	Trigger option for quality-change
TrgOp	trigger option

NOTE Abbreviations used for the identification of the common data classes and as names of the attributes are specified in the specific Clauses of this document and are not repeated here.

5 Conditions for attribute inclusion

This Clause lists general conditions that specify the presence of an attribute.

Abbreviation	Condition
M	Attribute is mandatory.
O	Attribute is optional.
PICS_SUBST	Attribute is mandatory, if substitution is supported (for substitution, see IEC 61850-7-2).
GC_1	At least one of the attributes shall be present for a given instance of DATA.
GC_2 (n)	All or none of the data attributes belonging to the same group (n) shall be present for a given instance of DATA.
GC_CON	A configuration data attribute shall only be present, if the (optional) specific data attributes to which this configuration relates, is also present.
AC_LN0_M	The attribute shall be present if the data NamPlt belongs to LLN0; otherwise it may be optional.
AC_LN0_EX	The attribute shall be present only if the data NamPlt belongs to LLN0 (applies to IdNs in CDC LPL only).
AC_DLD_M	The attribute shall be present, if LN name space of this LN deviates from the LN name space referenced by IdNs of the logical device in which this LN is contained (applies to InNs in CDC LPL only).
AC_DLN_M	The attribute shall be present, if data name space of this data deviates from the data name space referenced by either InNs of the logical node in which the data is contained or IdNs of the logical device in which the data is contained (applies to dataNs in all CDCs only).
AC_DLNDA_M	The attribute shall be present, if CDC name space of this data deviates from the CDC name space referenced by either the dataNs of the data, the InNs of the logical node in which the data is defined or IdNs of the logical device in which the data is contained (applies to cdcNs and cdcName in all CDCs only).
AC_SCAV	The presence of the configuration data attribute depends on the presence of i and f of the Analog Value of the data attribute to which this configuration attribute relates. For a given data object, that attribute - shall be present, if both i and f are present, - shall be optional if only i is present and - is not required if only f is present NOTE If only i is present in a device without floating point capabilities, the configuration parameter may be exchanged offline.

² Under consideration.

Abbreviation	Condition
AC_ST	The attribute is mandatory, if the controllable status class supports status information.
AC_CO_M	If the controllable status class supports control, this attribute is available and a mandatory attribute.
AC_CO_O	If the controllable status class supports control, this attribute is available and an optional attribute.
AC_SG_M	The attribute is mandatory, if setting group is supported.
AC_SG_O	The attribute is optional, if setting group is supported.
AC_NSQ_M	The attribute is mandatory, if setting group is not supported.
AC_NSQ_O	The attribute is optional, if setting group is not supported.
AC_RMS_M	The attribute is mandatory when the harmonics reference type is rms.

6 Common data attribute types

6.1 General

Common data attribute types are defined for the use in common data classes (CDC) in Clause 7.

IEC 61850-7-1 provides an overview of all IEC 61850-7 documents (IEC 61850-7-2, IEC 61850-7-3, and IEC 61850-7-4). IEC 61850-7-1 also describes the basic notation used in IEC 61850-7-3 and the description of the relations between the IEC 61850-7 documents.

NOTE The common data attribute type "TimeStamp" is specified in IEC 61850-7-2.

6.2 Quality

6.2.1 Overview

Quality type shall be as defined in Table 1.

Table 1 – Quality

Quality Type Definition			
Attribute Name	Attribute Type	Value/Value Range	M/O/C
	PACKED LIST		
validity	CODED ENUM	good invalid reserved questionable	M
detailQual	PACKED LIST		M
overflow	BOOLEAN		M
outOfRange	BOOLEAN		M
badReference	BOOLEAN		M
oscillatory	BOOLEAN		M
failure	BOOLEAN		M
oldData	BOOLEAN		M
inconsistent	BOOLEAN		M
inaccurate	BOOLEAN		M
source	CODED ENUM	process substituted DEFAULT process	M
test	BOOLEAN	DEFAULT FALSE	M
operatorBlocked	BOOLEAN	DEFAULT FALSE	M

The DEFAULT value shall be applied, if the functionality of the related attribute is not supported. The mapping may specify to exclude the attribute from the message, if it is not supported or if the DEFAULT value applies.

Quality shall be an attribute that contains information on the quality of the information from the server. The different quality identifiers are not independent. Basically, there are the following quality identifiers:

- validity;
- detail quality;
- source;
- test;
- blocked by operator.

NOTE The quality, as used within the scope of 61850, is related to the quality of the information from the **server**. There may be a requirement that the client uses additional quality information within its local database. This is a local issue and not part of the scope of IEC 61850. However, the quality of a client may have an impact on the quality supplied by a server of a client – server relationship at a higher level (see Figure 3).

6.2.2 Validity

Validity shall be good, questionable or invalid.

good: The value shall be marked good if no abnormal condition of the acquisition function or the information source is detected.

invalid: The value shall be marked invalid when an abnormal condition of the acquisition function or the information source (missing or non-operating updating devices) is detected. The value shall not be defined under this condition. The mark invalid shall be used to indicate to the client that the value may be incorrect and shall not be used.

EXAMPLE If an input unit detects an oscillation of one input it will mark the related information as invalid.

questionable: The value shall be marked questionable if a supervision function detects an abnormal behaviour, however the value could still be valid. The client shall be responsible for determining whether or not values marked "questionable" should be used.

6.2.3 Detail quality

The reason for an invalid or questionable value of an attribute may be specified in more detail with further quality identifiers. If one of these identifiers is set then validity shall be set to invalid or questionable. The following Table shows the relation of the detailed quality identifiers with invalid or questionable quality.

DetailQual	Invalid	Questionable
Overflow	X	
Out of Range	X	X
Bad Reference	X	X
Oscillatory	X	X
Failure	X	
Old data		X
Inconsistent		X
Inaccurate		X

overflow: this identifier shall indicate a quality issue that the value of the attribute to which the quality has been associated is beyond the capability of being represented properly (used for measurand information only).

EXAMPLE A measured value may exceed the range that may be represented by the selected data type, for example the data type is a 16-bit unsigned integer and the value exceeds 65535.

outOfRange: this identifier shall indicate a quality issue that the attribute to which the quality has been associated is beyond a predefined range of values. The server shall decide if validity shall be set to invalid or questionable (used for measurand information only).

EXAMPLE A measured value may exceed a predefined range, however the selected data type can still represent the value, for example the data type is a 16-bit unsigned integer, the predefined range is 0 to 40 000, if the value is between 40001 and 65535 it is considered to be out of range.

badReference: this identifier shall indicate that the value may not be a correct value due to a reference being out of calibration. The server shall decide if validity shall be set to invalid or questionable (used for measurand information and binary counter information only).

oscillatory: to prevent overloading of event driven communication channels, it is desirable to detect and suppress oscillating (fast changing) binary inputs. If a signal changes in a defined time (t_{osc}) twice in the same direction (from 0 to 1 or from 1 to 0) then it shall be defined as an oscillation and the detail quality identifier "oscillatory" shall be set. If a configured numbers of transient changes is detected, they shall be suppressed. In this time, the validity status "questionable" shall be set. If the signal is still in the oscillating state after the defined number of changes, the value shall be left in the state it was in when the oscillatory flag was set. In this case, the validity status "questionable" shall be reset and "invalid" shall be set as long as the signal is oscillating. If the configuration is such that all transient changes should be suppressed, the validity status "invalid" shall be set immediately in addition to the detail quality identifier "oscillatory" (used for status information only).

failure: this identifier shall indicate that a supervision function has detected an internal or external failure.

oldData: a value shall be oldData if an update is not made during a specific time interval. The value may be an old value that may have changed in the meantime. This specific time interval may be defined by an allowed-age attribute.

NOTE "Fail silent" errors, where the equipment stops sending data will cause a oldData condition. In this case, the last received information was correct.

inconsistent: this identifier shall indicate that an evaluation function has detected an inconsistency.

inaccurate: this identifier shall indicate that the value does not meet the stated accuracy of the source.

EXAMPLE The measured value of power factor may be noisy (inaccurate) when the current is very small.

6.2.4 Source

Source shall give information related to the origin of a value. The value may be acquired from the process or be a substituted value.

process: the value is provided by an input function from the process I/O or is calculated from some application function.

substituted: the value is provided by input of an operator or by an automatic source.

NOTE 1 Substitution may be done locally or via the communication services. In the second case, specific attributes with a FC SV are used.

NOTE 2 There are various means to clear a substitution. As an example, a substitution that was done following an invalid condition may be cleared automatically if the invalid condition is cleared. However, this is a local issue and therefore not in the scope of this standard.

6.2.5 Test

Test shall be an additional identifier that may be used to classify a value being a test value and not to be used for operational purposes. The processing of the test quality in the client shall be a local issue. The bit shall be completely independent from the other bits within the quality descriptor.

The test identifier should normally be propagated through all hierarchical levels.

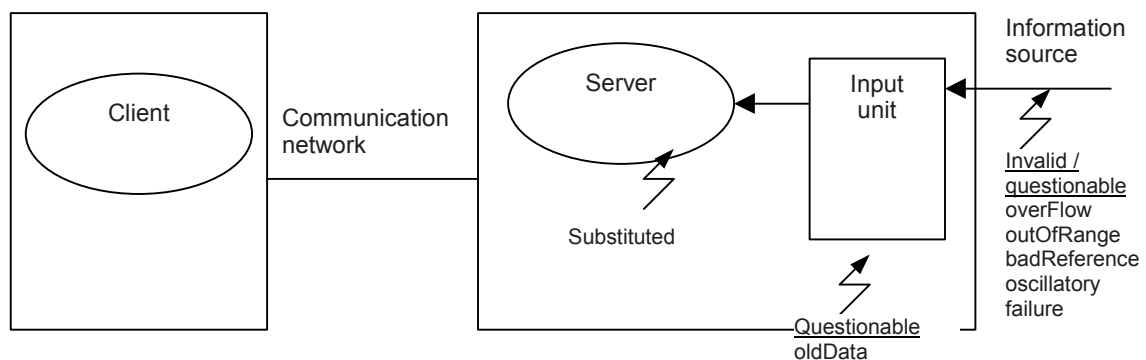
6.2.6 Blocked by operator

operatorBlocked: this identifier shall be set if further update of the value has been blocked by an operator. The value shall be the information that was acquired before blocking. If this identifier is set then the identifier oldData of detailQual shall also be set.

NOTE Both an operator as well as an automatic function may block communication updating as well as input updating. In both cases, detailQual.oldData will be set. If the blocking is done by an operator, then the identifier operatorBlocked is set additionally. In that case, an operator activity is required to clear the condition.

EXAMPLE An operator may block the update of an input, to save the old value, if the auxiliary supply is switched off.

6.2.7 Quality in the client server context



IEC 808/03

Figure 1 – Quality identifiers in a single client – server relationship

The quality identifier shall reflect the quality of the information in the server, as it is supplied to the client. Figure 1 shows potential sources that may influence the quality in a single client – server relationship. "Information Source" is the (hardwired) connection of the process information to the system. The information may be invalid or questionable as indicated in Figure 1. Further abnormal behaviour of the information source may be detected by the input unit. In that case, the input unit may keep the old data and flag it accordingly.

In a multiple client - server relationship, as shown in Figure 2, information may be acquired over a communication link (with Client B). If that communication link is broken, client B will detect that error situation and qualify the information as questionable/old data.

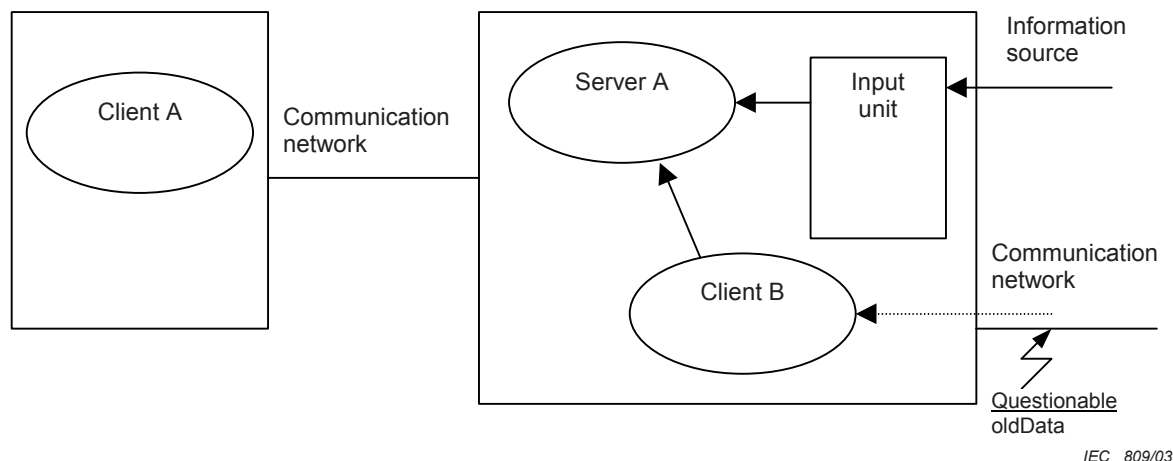


Figure 2 – Quality identifiers in a multiple client – server relationship

In the multiple client-server relationship, the quality of the data received from server A shall reflect both the quality of the server B (acquired with client B) as well as its own quality. Therefore, handling of prioritisation of quality from different levels may require further specification beyond that included in this standard. For the identifier **validity**, the value invalid shall dominate over the value questionable, since this is the worst case. For the identifier **source**, the higher level of the multiple client – server relationship shall dominate over the lower level.

EXAMPLE Let A be the higher level and B the lower level. The quality from server B is invalid. If now the communication fails (questionable, oldData) between server B and client B, the quality will remain invalid and not become questionable, since the last information was not correct. Server A therefore will report the information as invalid.

6.2.8 Relation between quality identifiers

Validity and **source** have a prioritised relation. If source is in the “process” state, then validity shall determine the quality of the origin value. If source is in the “substitute” state, then validity shall be overruled by the definition of the substituted value. This is an important feature, since substitution is used to replace invalid values with substituted values that may be used by the client such as good values.

EXAMPLE 1 If both questionable and substituted are set, this means that the substituted value is questionable. This may happen if, in a hierarchical configuration, a substitution is performed at the lowest level and the communication fails on a higher level.

EXAMPLE 2 If an invalid value is substituted, the invalid field will be cleared and the substituted field will be set to indicate the substitution.

The quality identifier **operatorBlocked** is independent of the other quality identifiers.

EXAMPLE 3 An oscillating input may cause the invalid field to be set. Due to the continuing changes in the value many reports are generated, loading the communication network. An operator may block the update of the input. In this case the field operatorBlocked will also be set.

An example for the interaction between the quality identifiers and the impact of multiple client – server relation is shown in Figure 3. In this example, it is assumed that a bay level device acts as a client of the process level server and as a server to the station level client.

NOTE This is one example of a multiple client – server relationship; other multiple client - server relationships may exist, but the behaviour will not change.

In case A, the input is blocked, the quality of the information is marked as questionable and oldData.

In case B, a substitution is done at process level. Now, the quality of the information to the next higher level (the bay level) is marked as substituted (but good).

In case C, the communication between process and bay level fails. Between bay level and station level, the information is still marked as substituted. In addition, questionable and oldData is set to indicate that the (substituted) information may be old.

In case D, a new substitution is made at bay level. Now the quality of the information to the next higher level is marked as substituted (and good) and is independent from the first substitution.

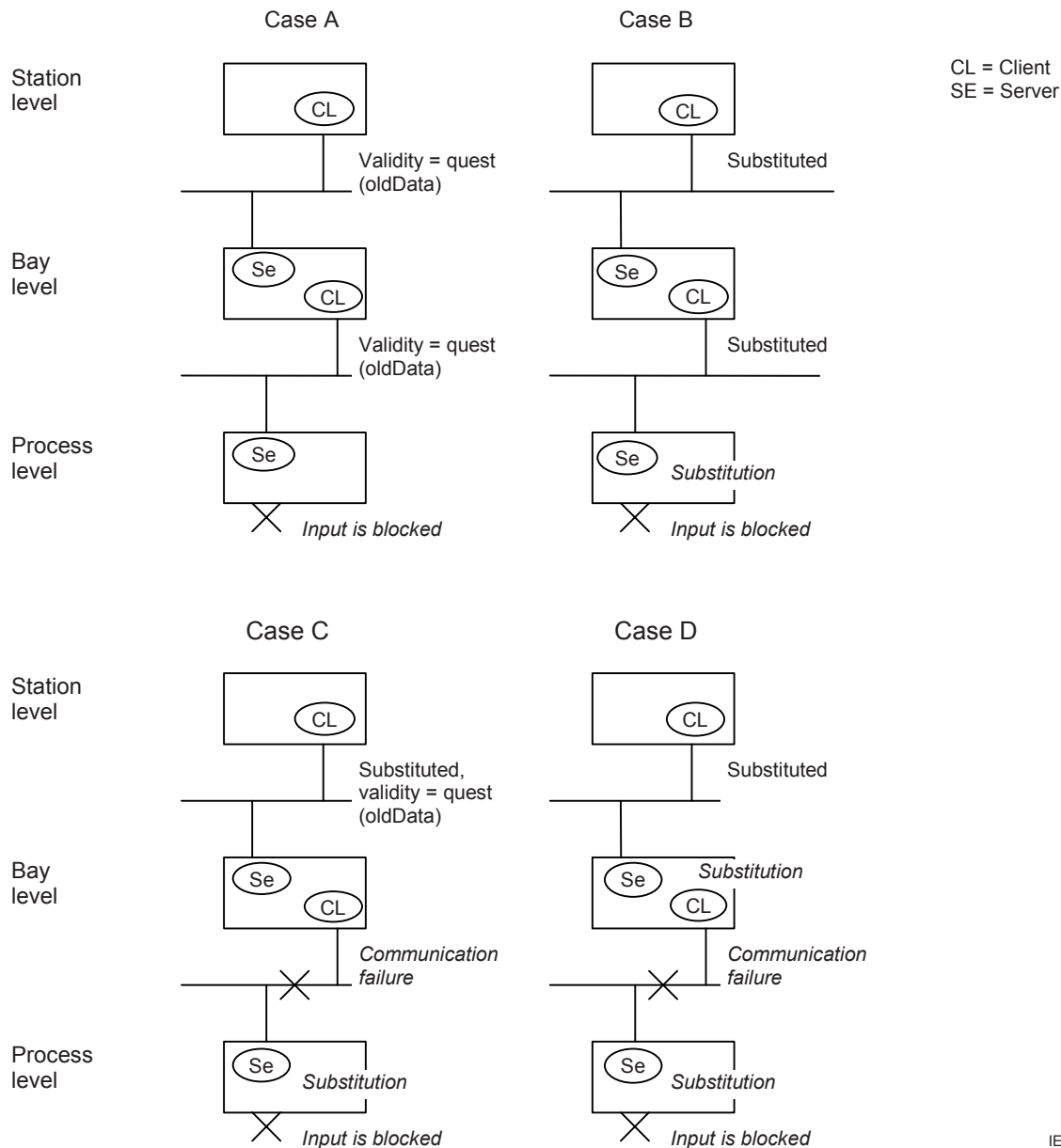


Figure 3 – Interaction of substitution and validity

6.3 Analogue value

Analogue value type shall be as defined in Table 2.

Table 2 – Analogue value

AnalogueValue Type Definition			
Attribute Name	Attribute Type	Value/Value Range	M/O/C
<i>i</i>	INT32	integer value	GC_1
<i>f</i>	FLOAT32	floating point value	GC_1

Analogue values may be represented as a basic data type INTEGER (attribute *i*) or as FLOATING POINT (attribute *f*). At least one of the attributes shall be used. If both *i* and *f* exist, the application has to insure that both values remain consistent. The latest value set by the communication service shall be used to update the other value. As an example, if xxx.f is written, the application shall update xxx.i accordingly.

i: The value of *i* shall be an integer representation of the measured value. The formula to convert between *i* and *f* shall be:

$$f \times 10^{units.multiplier} = (i \times scaleFactor) + offset$$

It shall be true within acceptable error when *i*, scaleFactor, offset and *f* are all present.

f: The value of *f* shall be the floating point representation of the measured value. *f* shall represent the technological value.

NOTE The reason for both integer and floating point representation is so that IEDs without FLOATING POINT capabilities shall be enabled to support analogue values. In this case, the scaleFactor and offset may be exchanged offline between clients and servers.

6.4 Configuration of analogue value

Configuration of analogue value type shall be as defined in Table 3.

Table 3 – Configuration of analogue value

ScaledValueConfig Type Definition			
Attribute Name	Attribute Type	Value/Value Range	M/O/C
scaleFactor	FLOAT32		M
offset	FLOAT32		M

This data attribute type shall be used to configure the INTEGER value representation of the analogue value. The formula for conversion between integer and floating point value is given in 6.3.

scaleFactor: the value of scaleFactor shall be the scaling factor.

offset: the value of offset shall be the offset.

6.5 Range configuration

Range configuration type is used to configure the limits that define the range of a measured value and shall be as defined in Table 4.

Table 4 – Range configuration

RangeConfig Type Definition			
Attribute Name	Attribute Type	Value/Value Range	M/O/C
hhLim	AnalogueValue		M
hLim	AnalogueValue		M
lLim	AnalogueValue		M
llLim	AnalogueValue		M
min	AnalogueValue		M
max	AnalogueValue		M

hhLim, hLim, lLim, llLim: These attributes shall be the configuration parameters used in the context with the range attribute as defined in clause 8.

min: the min (minimum) attribute shall represent the minimum process measurement for which values of *i* or *f* are considered within process limits. If the value is lower, q shall be set accordingly (validity = questionable, detailQual = outOfRange).

max: the max (maximum) attribute shall represent the maximum process measurement for which values of *i* or *f* are considered within process limits. If the value is higher, q shall be set accordingly (validity = questionable, detailQual = outOfRange).

6.6 Step position with transient indication

Step position with transient indication type is for example used to indicate the position of tap changers and shall be as defined in Table 5.

Table 5 – Step position with transient indication

ValWithTrans Type Definition			
Attribute Name	Attribute Type	Value/Value Range	M/O/C
posVal	INT8	–64 ... 63	M
transInd	BOOLEAN		O

The **posVal** shall contain the step position, the **transInd** shall indicate that the equipment is in a transient state.

6.7 Pulse configuration

Pulse configuration type is used to configure the output pulse generated with a command and shall be as defined in Table 6.

Table 6 – Pulse configuration

PulseConfig Type Definition			
Attribute Name	Attribute Type	Value/Value Range	M/O/C
cmdQual	ENUMERATED	pulse persistent	M
onDur	INT32U		M
offDur	INT32U		M
numPls	INT32U		M

cmdQual: this identifier shall define if the control output is a pulse output or if it is a persistent output. If it is set to pulse, then the duration of the pulse shall be defined with the identifiers onDur, offDur and numPls. If it is set to persistent, the deactivation of the output pulse is a local issue determined in the server; as an example, when a switch controlled by this control output has reached the end position, the local control logic in the in the device implementing the server will deactivate the output.

onDur, offDur, numPls: as the result of receiving an **Operate** service, a pulsed output may be generated to the **on** or **off** input of a switching device. The shape of this output is defined by onDur, offDur and numPls according to Figure 4. NumPls shall specify the number of pulses that are generated. onDur shall specify the on duration of the pulse, offDur specifies the duration between two pulses. onDur and offDur shall be specified in ms; a value of 0 ms shall specify that the duration is locally defined.

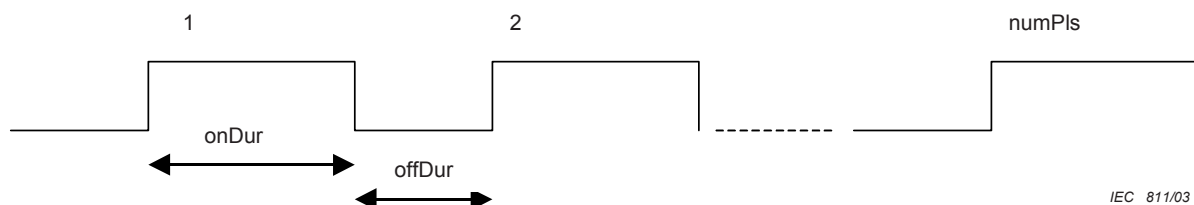


Figure 4 – Configuration of command output pulse

6.8 Originator

Originator type shall be as defined in Table 7.

Table 7 – Originator

Originator Type Definition			
Attribute Name	Attribute Type	Value/Value Range	M/O/C
orCat	ENUMERATED	not-supported bay-control station-control remote-control automatic-bay automatic-station automatic-remote maintenance process	M
orIdent	OCTET STRING64		M

Originator shall contain information related to the originator of the last change of the data attribute representing the value of a controllable data.

orCat: The originator category shall specify the category of the originator that caused a change of a value. An explanation of the values for orCat is given in Table 8.

Table 8 – Values for orCat

Value	Explanation
not-supported	orCat is not supported
bay-control	Control operation issued from an operator using a client located at bay level
station-control	Control operation issued from an operator using a client located at station level
remote-control	Control operation from a remote operator outside the substation (for example network control center)
automatic-bay	Control operation issued from an automatic function at bay level
automatic-station	Control operation issued from an automatic function at station level
automatic-remote	Control operation issued from a automatic function outside of the substation
maintenance	Control operation issued from a maintenance/service tool
process	Status change occurred without control action (for example external trip of a circuit breaker or failure inside the breaker)

orIdent: the originator identification shall show the address of the originator who caused the change of the value. The value of NULL shall be reserved to indicate that the originator of a particular action is not known or is not reported.

NOTE The type of address stored (application address, IP address, link address, ...) is whatever the server can detect. This may depend on the specific mapping

6.9 Unit definition

Unit type shall be as defined in Table 9.

Table 9 – Unit

Unit Type Definition			
Attribute Name	Attribute Type	Value/Value Range	M/O/C
SIUnit	ENUMERATED	According to Tables A.1 to A.4 in Annex A	M
multiplier	ENUMERATED	According to Table A.5 in Annex A	O

SIUnit: shall define the SI unit according to Annex A.

multiplier: shall define the multiplier value according to Annex A. The default value is 0 (i.e. multiplier = 1).

6.10 Vector definition

Vector type shall be as defined in Table 10.

Table 10 – Vector

Vector Type Definition			
Attribute Name	Attribute Type	Value/Value Range	M/O/C
mag	AnalogueValue		M
ang	AnalogueValue		O