



BSI Standards Publication

## Communication networks and systems for power utility automation

---

Part 90-11: Methodologies for modelling of logics  
for IEC 61850 based applications

## National foreword

This Published Document is the UK implementation of IEC TR 61850-90-11:2020.

The UK participation in its preparation was entrusted to Technical Committee PEL/57, Power systems management and associated information exchange.

A list of organizations represented on this committee can be obtained on request to its committee manager.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

© The British Standards Institution 2020  
Published by BSI Standards Limited 2020

ISBN 978 0 539 15599 0

ICS 33.200

**Compliance with a British Standard cannot confer immunity from legal obligations.**

This Published Document was published under the authority of the Standards Policy and Strategy Committee on 31 October 2020.

### Amendments/corrigenda issued since publication

Date	Text affected
------	---------------

---



# IEC TR 61850-90-11

Edition 1.0 2020-09

## TECHNICAL REPORT



**Communication networks and systems for power utility automation –  
Part 90-11: Methodologies for modelling of logics for IEC 61850 based  
applications**

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

ICS 33.200

ISBN 978-2-8322-8785-9

**Warning! Make sure that you obtained this publication from an authorized distributor.**

CONTENTS

FOREWORD ..... 6

INTRODUCTION ..... 8

1 Scope ..... 9

    1.1 General ..... 9

    1.2 Published versions of this standard and related namespace name ..... 10

    1.3 Namespace name and version ..... 10

    1.4 Code Component distribution ..... 11

        1.4.1 General ..... 11

        1.4.2 Data model namespace code component ..... 11

        1.4.3 XML schema namespace code component ..... 12

2 Normative references ..... 12

3 Terms and definitions ..... 12

4 Abbreviated terms ..... 13

5 Use cases ..... 13

    5.1 General ..... 13

    5.2 Use case 1 – Busbar disconnecter coupled in a double busbar arrangement ..... 14

    5.3 Use case 2 – Delayed breaker trip and blocking after low gas pressure alarm ..... 15

    5.4 Use case 3 – Bay connected to a busbar ..... 16

    5.5 Use case 4 – Definite trip ..... 17

    5.6 Use case 5 – "Direct transfer open operation" ..... 18

    5.7 Use case 6 – Line outage detection in a breaker and a half scheme ..... 19

    5.8 Use case 7 – Unit trip logic ..... 21

    5.9 Use case 8 – Data quality management ..... 22

    5.10 Use case 9 – Switchgear control on the example of a busbar change-over sequence ..... 24

    5.11 Conclusions ..... 25

6 Functional requirements for logic modelling ..... 25

    6.1 Performance requirements ..... 25

    6.2 Specific management of Common Data Class (CDC) attributes ..... 26

        6.2.1 General ..... 26

        6.2.2 Quality ..... 26

        6.2.3 Time stamp ..... 27

    6.3 Switchgear control ..... 27

        6.3.1 Variant A: Control commands using control services on CSWI.Pos ..... 27

        6.3.2 Variant B: Control commands using GOOSE messages to XCBR/XSWI ..... 28

        6.3.3 Variant C: Control commands using GOOSE messages to CSWI ..... 29

        6.3.4 Conclusions on switchgear control issued by logics ..... 30

        6.3.5 Functional restrictions ..... 31

7 Intended engineering process of logic ..... 32

    7.1 General ..... 32

    7.2 Management of logic at IED level ..... 34

    7.3 Distributed logic management ..... 34

8 Logic modelling ..... 34

    8.1 Functional view for logics ..... 34

    8.2 Logical node instantiation hosting logic units ..... 36

8.3	Operational modes.....	36
8.4	Logic unit engine execution state.....	37
8.5	Change of logics IEC 61131 parameters and schemes.....	37
8.6	Variable types and qualifiers.....	38
8.7	Variable names and binding conventions.....	38
8.8	Management of data quality attributes.....	39
8.9	Management of time stamp.....	40
8.10	Substitution model.....	41
8.11	Management of switchgear controls.....	42
8.12	Analogue values.....	42
8.13	Services.....	42
8.14	Initialisation.....	43
8.15	Standard language to describe the content of a logic unit.....	43
8.16	Mapping of IEC 61850 data types and IEC 61131-3 / PLCopen XML data types.....	43
8.16.1	General.....	43
8.16.2	IEC 61850 basic types mapping to IEC 61131-3.....	43
8.16.3	IEC 61850 Common ACSI Types mapping to IEC 61131-3.....	44
8.16.4	IEC 61850 constructed attribute classes mapping to IEC 61131-3.....	44
8.16.5	IEC 61850 CDC mapping to IEC 61131-3.....	46
8.16.6	IEC 61850 logical node data objects mapping to IEC 61131-3.....	53
8.17	Operators.....	53
8.18	Logics monitoring, testing and debugging.....	53
8.19	IEC TR 61850-90-11 data model names space definition.....	53
8.19.1	General.....	53
8.19.2	Abbreviations.....	53
8.19.3	Logical node classes.....	54
8.19.4	Enumerated data attribute types.....	57
8.20	IEC TR 61850-90-11 XML namespace definition.....	58
8.20.1	General.....	58
8.20.2	XML element.....	58
9	Conformance testing.....	59
10	Testing of logic functions.....	60
11	Effects on other parts of IEC 61850.....	60
11.1	IEC 61850-3.....	60
11.2	IEC 61850-7-4.....	60
11.3	IEC 61850-6.....	60
11.4	IEC 61850-10.....	60
Annex A	(informative) Use of SCL extension facilities for Logic Modelling.....	61
Annex B	(informative) PLD example.....	64
B.1	Overview.....	64
B.2	PLD file.....	64
B.3	Use of a logic unit in a GAPC logical node instance.....	70
Annex C	(informative) Type compatibility for input/blocking references.....	73
Annex D	(informative) Semantic of name plate attributes.....	74
Annex E	(informative) Quality behaviour in user-defined logics.....	75
Annex F	(informative) Proposal of a solution for quality handling.....	76
F.1	Two ways of engineering logics.....	76

F.1.1	General .....	76
F.1.2	Details of the solution "quality handling" and the extensions needed.....	76
F.1.3	Application example for "processed as invalid" .....	78
F.1.4	Effects on other parts of IEC 61850 .....	78
F.2	SCD including definitions for quality handling.....	78
F.3	Lessons learnt from this exercise .....	83
Annex G (informative)	Example of an engineering workflow .....	84
G.1	Workflow of interfacing the logics part (written in IEC 61131) in the IEC 61850 configuration, starting from SCD file .....	84
G.2	Lessons learnt from this exercise .....	86
Annex H (informative)	Proposal of a protection against IEC 61131 engineering changes.....	87
Annex I (informative)	Mapping from IEC 61850 CDC to PLCOpen XML.....	88
Bibliography.....		101
Figure 1 – Performance timing concepts .....		26
Figure 2 – Scheme of variant A.....		28
Figure 3 – Scheme of variant B.....		29
Figure 4 – Scheme of variant C.....		30
Figure 5 – Engineering process for logic based on IEC 61131-3 .....		33
Figure 6 – Functional view of a logical node.....		35
Figure 7 – Logic unit inside a GAPC logical node.....		35
Figure 8 – GAPC logical node instantiation .....		36
Figure 9 – Binding.....		39
Figure 10 – Management of quality data attributes .....		40
Figure 11 – Class diagram LogicalNodes_90_11::LogicalNodes_90_11 .....		54
Figure 12 – Class diagram LNGroup::LNGroupG .....		55
Figure 13 – Class diagram DOEnums_90_11::DOEnums_90_11.....		57
Figure 14 – UML representation of the IEC TR 61850-90-11 XML namespace .....		59
Figure B.1 – PLD file hosted in a GAPC LN instance (on the example of use case 5 – Direct transfer open operation) .....		64
Figure E.1 – Quality behaviour table .....		75
Table 1 – Tracking information of (Tr)IEC 61850-90-11:2019A namespace building-up.....		7
Table 2 – Reference between published versions of the standard and related namespace name.....		10
Table 3 – Attributes of data model namespace.....		10
Table 4 – Attributes of xsd namespace .....		11
Table 5 – Use case 1 definition.....		14
Table 6 – Use case 2 definition.....		15
Table 7 – Use case 3 definition.....		16
Table 8 – Use case 4 definition.....		17
Table 9 – Use case 5 definition.....		18
Table 10 – Use case 6 definition.....		20
Table 11 – Use case 7 definition.....		21

Table 12 – Use case 8 definition .....	22
Table 13 – Example of a quality definition .....	23
Table 14 – Use case 9 definition .....	24
Table 15 – Data object definition for control outputs.....	31
Table 16 – Configurations for the control output conditioner.....	31
Table 17 – Data object definition for operational modes .....	37
Table 18 – PlcOpModeKind enumeration definition .....	37
Table 19 – Variable types and qualifiers .....	38
Table 20 – Allowed IEC 61131-3 qualifiers for data variables .....	38
Table 21 – Data object definition for time stamp calculation .....	41
Table 22 – CalcTimeAssignmentMethodKind enumeration definition .....	41
Table 23 – Data object definition for analogue measured values .....	42
Table 24 – Mapping of basic data types from IEC 61850-7-2.....	43
Table 25 – Mapping of constructed attribute classes from IEC 61850-7-3 .....	44
Table 26 – Mapping of Common Data Classes from IEC 61850-7-3 .....	47
Table 27 – Normative abbreviations for data object names .....	53
Table 28 – Data objects of GAPCExt .....	56
Table 29 – Literals of PlcOpModeKind .....	58
Table 30 – Literals of CalcTimeAssignmentMethodKind.....	58
Table 31 – SICS Table G.1 – IED configurator conformance statement.....	60
Table C.1 – CDC types for InRef/BlkRef .....	73
Table D.1 – Semantics of name plate attributes of DPC LN with Logic unit instances .....	74
Table F.1 – New CF attributes of DPC .....	77
Table F.2 – ComBehaviourKind enumeration definition .....	78
Table F.3 – Configurations for the example.....	78
Table G.1 – Workflow definition .....	84

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**COMMUNICATION NETWORKS AND SYSTEMS  
FOR POWER UTILITY AUTOMATION –****Part 90-11: Methodologies for modelling of logics  
for IEC 61850 based applications**

## FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the most recent edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

The main task of IEC technical committees is to prepare International Standards. However, a technical committee may propose the publication of a technical report when it has collected data of a different kind from that which is normally published as an International Standard, for example "state of the art".

Technical report IEC 61850-90-11 has been prepared by Technical Committee 57: Power systems management and associated information exchange.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2. This IEC standard includes Code Components i.e. components that are intended to be directly processed by a computer.

Such content is any text found between the markers <CODE BEGINS> and <CODE ENDS>, or otherwise is clearly labelled in this standard as a Code Component.

The purchase of this IEC standard carries a copyright license for the purchaser to sell software containing Code Components from this standard to end users either directly or via distributors, subject to IEC software licensing conditions, which can be found at: <http://www.iec.ch/CCv1>.

Table 1 shows all tracking information of (Tr)IEC 61850-90-11:2019A namespace building-up.

**Table 1 – Tracking information of (Tr)IEC 61850-90-11:2019A namespace building-up**

Attribute	Content
<b>Namespace IEC specific information</b>	
Version of the UML model used for generating the document (informative)	WG10built7
Date of the UML model used for generating the document (informative)	2020-05-19
Autogeneration software name and version (informative)	j61850DocBuilder 01v03 based on jClear Cims v02-NS beta6

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

Enquiry draft	Report on voting
57/2129A/DTR	57/2211/PVDT R

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

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

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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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

## INTRODUCTION

This part of IEC 61850, which is a Technical Report, describes the methodologies for the modelling of logics for IEC 61850 based applications. IEC 61850 defines communication networks and systems for power utility automation, and more specifically the communication architecture for subsystems like power system automation systems. The defined architecture in part IEC 61850-7-x provides both a power utility specific data model and a substation domain specific data model with abstract definitions of data objects classes and services independently from the specific protocol stacks, implementations, and operating systems. The mapping of these abstract classes and services to communication stacks is outside the scope of IEC 61850-7-x and can be found in IEC 61850-8-x and in IEC 61850-9-x.

IEC 61850-7-1 gives an overview of the basic communication architecture to be used for all applications in the power utility domain. IEC 61850-7-3 defines common attribute types and common data classes related to all applications in the power system domain. The attributes of the common data classes can be accessed using services defined in IEC 61850-7-2. These common data classes are used in this part to define the compatible data object classes.

To reach interoperability, all data objects in the data model (IEC 61850-7-3, IEC 61850-7-4) need a strong definition with regard to syntax and semantics. The semantics of the data objects is mainly provided by names assigned to common logical nodes defined and data objects they contain, as defined in part IEC 61850-7-4, and dedicated logical nodes defined in domain specific parts like for hydro power control systems (IEC 61850-7-410).

A data object with full semantics is only one of the elements required to achieve interoperability. The standardised access to the data objects is defined in compatible, power utility and domain specific services (see IEC 61850-7-2). Since data objects and services are hosted by intelligent electronic devices (IED), a proper device model is needed also. To describe both the device capabilities and the interaction of the devices in the related system, also a configuration language is needed as defined in part IEC 61850-6 by the System Configuration description Language (SCL).

Besides the application of functions based on predefined logical nodes as given by IEC 61850-7-4 or other domain standards, there is a need to manage project specific logic schemes. These logic schemes define logic operations across logical nodes implementing a function. An increased benefit of IEC 61850 system engineering is the capability of the IEDs to handle such user programmable logics modelled with IEC 61850 concepts. This document provides a standardised methodology to describe and manage logic which is applicable for both on a local function as well as for distributed function logic.

Logics are not limited to functions represented by GAPC class as described in this document. The modelling principles can be applied to all LN classes containing the needed information. Since GAPC class offers the widest flexibility in application, which goes with the usage of logics, this LN class is taken as an example in this document.

## COMMUNICATION NETWORKS AND SYSTEMS FOR POWER UTILITY AUTOMATION –

### Part 90-11: Methodologies for modelling of logics for IEC 61850 based applications

## 1 Scope

### 1.1 General

This part of IEC 61850, which is a Technical Report, describes the methodologies for the modelling of logics for IEC 61850 based applications in power utility automation. In particular, it describes the functional view of logic based on existing logical nodes for generic process automation and the operational modes of the logic. Furthermore it includes the specification of the standard language to be applied to specific the logic as well as the related data exchange format between engineering tools and their application as well as the mapping of logic elements to IEC 61850 data types.

The examples or use cases given in this document are based on the class model introduced in IEC 61850-7-1 and defined in IEC 61850-7-3. The logical node and data names used in this document are defined in IEC 61850-7-4, the services applied in IEC 61850-7-2. The naming conventions of IEC 61850-7-2 are applied in this document also.

If extensions are needed in the application examples, the normative naming rules for multiple instances and private, compatible extensions of Logical Node (LN) Classes and Data Object Names defined in IEC 61850-7-1 are considered.

This document describes the use of IEC 61850 extensions for modelling logics, therefore it implies some tutorial material. However it is advisable to read IEC 61850-6 and IEC 61850-7-1 in conjunction with IEC 61850-7-3 and IEC 61850-7-2 first and IEC 61131-3 as reference for the programming language of logic.

The different logics included in any IED in an IEC 61850 based system can be classified into two groups:

- **Fixed Logic:** These logics are predefined mostly for critical and complex functions. They are typically included in the IED's defined application, potentially implemented in software, firmware or hardware, and are not modifiable with IEC 61850 tools and services. These logics are implementation specific. Fixed logic is out of the scope of this document.
- **Editable Logic:** These are user configurable / programmable logics which shall be modelled through IEC 61850 configuration tools and be accessible by IEC 61850 services. These logics can be application specific.

The major goal of this document is to adopt the given functionality of an IED to fit to specific application function demands. This is to provide a definition of the methodology for describing and exchanging logics using an IEC 61850 compatible solution. As a benefit the same logic description will be valid and vendor-independent, so it could be used for different IEDs. It is up to the tools to understand this standard description in order to be able to manipulate the logics and to properly configure the IEDs.

Graphical representation of logic is currently out-of-scope of the IEC 61850 series, even if it is part of the PLCopen XML specification. The representation is subject to the engineering tools.