



BSI Standards Publication

# Power systems management and associated information exchange — Interoperability in the long term

Part 102: CIM — IEC 61850 harmonisation

## National foreword

This Published Document is the UK implementation of IEC TS 62361-102:2018.

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 secretary.

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 2018  
Published by BSI Standards Limited 2018

ISBN 978 0 580 89477 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 30 April 2018.

### Amendments/corrigenda issued since publication

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

---



# IEC TS 62361-102

Edition 1.0 2018-03

## TECHNICAL SPECIFICATION



---

**Power systems management and associated information exchange –  
Interoperability in the long term –  
Part 102: CIM – IEC 61850 harmonization**

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

---

ICS 33.200

ISBN 978-2-8322-5454-7

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

## CONTENTS

FOREWORD.....	7
INTRODUCTION.....	9
1 Scope.....	10
2 Normative references .....	11
3 Terms, definitions and abbreviated terms .....	11
3.1 Terms and definitions.....	12
3.2 Abbreviated terms.....	12
4 Use case summary .....	13
4.1 General.....	13
4.2 SCADA/EMS/DMS configuration from IEC 61850 SCL .....	13
4.3 Importing SCADA/EMS/DMS requirements into IEC 61850 SCL.....	14
4.3.1 General .....	14
4.3.2 Recommendation for harmonization: SCL Process/Substation "line" section.....	14
4.4 SCADA commissioning use case .....	14
4.5 Volt Var control use case .....	15
4.6 Wide Area Monitoring, Protection and Control (WAMPAC) for transient stability .....	16
5 Mapping SCL to SCADA/EMS/DMS relevant CIM .....	16
5.1 Business requirements.....	16
5.2 Profiles .....	17
5.3 IEC 61850 modelling principles .....	17
5.3.1 Introduction .....	17
5.3.2 System Configuration description language (SCL) .....	17
5.3.3 Logical Devices and Logical Nodes .....	17
5.3.4 SCL sections .....	18
5.4 Mapping overview .....	18
5.4.1 SCL Document Types .....	18
5.4.2 General mapping principles .....	19
5.5 SCL Substation section mapping.....	22
5.5.1 Overview .....	22
5.5.2 SCL elements and CIM classes mapping .....	26
5.6 Equipment types and codes .....	29
5.6.1 General .....	29
5.6.2 Equipment type code mapping .....	29
5.6.3 Recommendation for harmonization: SCL Equipment Type codes.....	31
5.6.4 Recommendation for harmonization: SCL PSRType .....	33
5.6.5 Recommendation for harmonization: CIM BusbarSection and Junction .....	34
5.6.6 Recommendation for harmonization: CIM Fan, Motor, Batteries and charging systems.....	34
5.7 Naming and identification mapping .....	34
5.7.1 General .....	34
5.7.2 Naming and identification example .....	35
5.7.3 Recommendation for harmonization: SCL naming and identification .....	36
5.7.4 Recommendation for harmonization: CIM naming and identification:.....	36
5.8 Voltage mapping.....	36
5.8.1 General .....	36

5.8.2	Voltage mapping example.....	37
5.8.3	Voltage level additional attributes .....	37
5.9	Connectivity modelling .....	37
5.9.1	SCL Connectivity (single line diagram) modelling.....	37
5.9.2	Recommendation for harmonization: SCL unconnected terminals .....	39
5.9.3	Connectivity and Terminal example .....	39
5.9.4	Transformation of current transformer models.....	42
5.10	Phase modelling .....	42
5.10.1	General .....	42
5.10.2	Phase mapping example.....	44
5.10.3	Recommendation for harmonization: SCL Phase modeling .....	47
5.10.4	Recommendation for harmonization: CIM SinglePhaseKind .....	47
6	Extension syntax for drawing layout coordinates.....	47
6.1	General.....	47
6.2	Recommendation for harmonization: Drawing layout syntax .....	47
7	Logical Node mapping .....	48
7.1	Logical Node containers.....	48
7.2	CIM Measurement associations .....	48
7.2.1	General .....	48
7.2.2	Recommendation for harmonization: CIM SCA package.....	49
7.3	Logical Node classes relevant to CIM .....	50
8	Measurement mapping .....	53
8.1	General.....	53
8.2	CIM Measurement Types – Logical Node and Data Object mapping.....	53
8.2.1	General .....	53
8.2.2	Recommendation for harmonization: CIM Measurement types .....	55
8.3	Measurement associations.....	56
8.4	CSWI or XSWI/XCBR as source of switch position information.....	56
8.5	Direction of positive flow .....	56
8.5.1	General .....	56
8.5.2	Recommendation for harmonization: SCL power flow direction .....	57
8.5.3	Recommendation for harmonization: CIM power flow direction.....	57
8.6	CIM Extensions for Distribution – Metering Model and Reading Types .....	57
9	Real time data exchange mapping .....	58
9.1	Measurement identification .....	58
9.2	Common Data Class mapping .....	58
9.3	Common Data Class mapping to IEC 60870 and CIM Measurements .....	59
9.4	Common Data Class mapping to IEEE1815 and CIM.....	62
9.5	Data Attribute mapping .....	62
9.5.1	General .....	62
9.5.2	Quality flag mapping .....	63
9.5.3	Non-real time measurement attribute mapping.....	64
9.5.4	Recommendation for harmonization: CIM measurement classes .....	64
10	Control Model.....	64
10.1	CIM Control Modelling.....	64
10.1.1	General .....	64
10.1.2	Recommendation for harmonization: CIM control model .....	65
10.1.3	Recommendation for harmonization: CIM CONTROL TYPES.....	66

10.2	Automated control sequences .....	66
11	Protection modelling .....	66
12	Communication model .....	68
13	Settings and attributes .....	68
Annex A	(informative) Use case details .....	80
A.1	SCADA/EMS/DMS configuration from IEC 61850 SCL – Description .....	80
A.1.1	Name of use case .....	80
A.1.2	Scope and objectives of use case .....	80
A.1.3	Narrative of use case .....	80
A.1.4	General remarks .....	82
A.2	Use case diagrams .....	82
A.3	Technical details .....	86
A.3.1	Actors: People, systems, applications, databases, the power system and other stakeholders .....	86
A.3.2	Preconditions, assumptions, post condition, events .....	89
A.3.3	References / Issues .....	89
A.3.4	Further Information on the use case for classification / mapping .....	90
A.4	Step by step analysis of use case .....	90
A.4.1	Pre-conditions .....	90
A.4.2	Steps – Normal .....	91
A.4.3	Steps – Alternative, error management and/or maintenance/backup scenario .....	93
A.5	Information exchanged .....	94
A.6	Common terms and definitions .....	94
Annex B	(informative) Use case details .....	95
B.1	Wide Area Monitoring, Protection and Control system (WAMPAC) for Transient stability .....	95
B.1.1	Name of Use Case .....	95
B.1.2	Scope and objectives of use case .....	96
B.1.3	Narrative of use case .....	103
B.2	Use case diagram .....	105
B.3	Technical details .....	106
B.3.1	Actors: People, systems, applications, databases, the power system, and other stakeholders .....	106
B.3.2	Preconditions, assumptions, post condition, event .....	107
B.3.3	References / issues .....	107
B.3.4	Further information on the use case for classification / mapping .....	108
B.4	Step by step analysis of use case .....	108
B.4.1	Overview of scenarios .....	108
B.4.2	Steps – Alternative, error management, and/or maintenance/backup scenario .....	109
B.5	Information exchanged .....	111
Annex C	(informative) Recommendations .....	115
C.1	Recommendations for IEC 61850 .....	115
C.2	Recommendations for CIM based standards, particularly IEC 61970-301 .....	116
C.3	Recommendations for joint working groups .....	117
Bibliography	.....	118

Figure 1 – IEC 61850 and CIM data flows .....	15
Figure 2 – Mapping for Wide Area Monitoring Protection and Control.....	16
Figure 3 – Equipment mapping .....	21
Figure 4 – Example of equipment and status measurement mapping .....	22
Figure 5 – UML class diagram of SCL entities showing inheritance .....	24
Figure 6 – UML class diagram of SCL entities showing inheritance and containment .....	25
Figure 7 – UML class diagram of SCL equipment connectivity and phase information .....	26
Figure 8 – Composite Switch example. ....	33
Figure 9 – Substation section connectivity example .....	40
Figure 10 – Three-phase (left) and single-phase control (right) .....	43
Figure 11 – Unbalanced phase switching example .....	45
Figure 12 – Current CIM SCADA package.....	49
Figure 13 – Revised SCADA package .....	50
Figure 14 – Signal identification as defined in IEC 61850-7-2 .....	58
Figure 15 – UML model of MV, DEL and WYE data classes .....	59
Figure 16 – Current CIM Control Model.....	65
Figure 17 – Proposal for revised CIM Control Model .....	66
Figure 18 – Present IEC 61970 Protection Model.....	67
Figure A.1 – Activity diagram part 1 – Create and review system specification description.....	83
Figure A.2 – Activity diagram part 2 – Create and review system configuration description.....	84
Figure A.3 – Sequence diagram.....	85
Table 1 – Overview of SCL and CIM component parts .....	19
Table 2 – Mapping between SCL Data Types and CIM classes.....	27
Table 3 – Equipment type codes .....	29
Table 4 – Equipment type codes – proposed modified descriptions .....	32
Table 5 – Equipment type codes – proposed additional codes .....	33
Table 6 – Name mapping .....	35
Table 7 – Proposed CIM NameType class naming conventions.....	36
Table 8 – Base voltage mapping .....	37
Table 9 – Attributes for terminal.....	38
Table 10 – Attributes for ConnectivityNode .....	39
Table 11 – Comparison of IEC 61850 and CIM Phase values.....	44
Table 12 – Breaker mapping scenarios .....	44
Table 13 – Mapping IEC 61850 Logical Nodes to CIM classes .....	51
Table 14 – IEC 61850 DataObjects vs Current CIM measurement types .....	54
Table 15 – IEC 61850 DataObjects for non-three phase measurements.....	55
Table 16 – IEC 61850 DataObjects for CIM control types.....	55
Table 17 – Mapping IEC 61850 Common Data Classes to IEC 60870 information objects and CIM classes .....	60

Table 18 – Mapping IEEE1815 data point types to CIM classes .....	62
Table 19 – Mapping IEC 61850 real time data attributes to CIM classes/attributes .....	63
Table 20 – Mapping IEC 61850 Non-real time data attributes to CIM classes/attributes .....	64
Table 21 – Mapping SCL Communication elements.....	68
Table 22 – Mapping IEC 61850 settings to CIM attributes .....	70

Currently in preview, click buy full version

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**POWER SYSTEMS MANAGEMENT AND ASSOCIATED INFORMATION  
EXCHANGE – INTEROPERABILITY IN THE LONG TERM –****Part 102: CIM – IEC 61850 harmonization**

## 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, accept 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 latest 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. In exceptional circumstances, a technical committee may propose the publication of a technical specification when

- the required support cannot be obtained for the publication of an International Standard, despite repeated efforts, or
- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC TS 62361-102, which is a technical specification, has been prepared by IEC technical committee 57: Power systems management and associated information exchange.

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

Enquiry draft	Report on voting
57/1706/DTS	57/1948/RVDTS

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

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

A list of all parts in the IEC 62361 series, published under the general title *Power systems management and associated exchange – Interoperability in the long term*, can be found on the IEC website.

In this publication, the following print types are used:

- *Associations: in italic type.*

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

- transformed into an International standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

**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 content. Users should therefore print this document using a colour printer.**

## INTRODUCTION

The IEC focuses primarily on specifying the payload of various functionally oriented messages or file exchanges. This concept includes configuration files like those developed in all IEC power systems management standards. The different smart grid initiatives in the USA, Europe and Asia have all recognized the necessity to establish solid standards for communicating between all the "smart" devices. For interoperability purposes, it has been recognized, at an early stage, that widely shared semantics would be necessary. Unfortunately, the semantic models used by the technical groups have differed from the start due to the different needs for information exchange within substations and information exchange within control centres. This has led to some gaps between the models within different standards, even though they reflected the same power system entities. Various institutions have requested that we narrow the gaps:

- NIST has recommended harmonization as a mechanism to decrease cost of integration in the Smart Grid.
- CEN/CENELEC/ETSI Smart Grid Coordination Group report states: "Harmonized electronic data model and description language are missing" and strongly recommends the study of "Harmonized glossary, semantic & modelling between CIM and IEC 61850".
- ENTSO-E letter states: "There is also a need to perform a harmonization between IEC 61850 and IEC CIM (Common Information Model) Standards [...] There are applications which use both set of standards and significant improvements on interoperability and data exchange between the applications should take place."

A number of studies and reports have already been produced on the subject of Harmonization as listed in the Bibliography.

# POWER SYSTEMS MANAGEMENT AND ASSOCIATED INFORMATION EXCHANGE – INTEROPERABILITY IN THE LONG TERM –

## Part 102: CIM – IEC 61850 harmonization

### 1 Scope

This part of IEC 62361, which is a Technical Specification, outlines a technical approach for achieving effective information exchange between power system installations governed by IEC 61850 and business systems integrated with IEC CIM standard data exchanges, based on a selected specific set of use cases, but also with the goal of creating a framework that will extend successfully to other use cases in the future. This document includes proposals to 'harmonize' the two standards by adapting or extending existing information models and/or defining new models, where such changes will enable more effective communication. Both current and future directions of models will be considered. The report will take into account existing standards for semantics, services, protocols, system configuration language, and architecture.

It was intended to be coordinated with IEC 61850 and all affiliated subgroups as well as IEC 61968 and IEC 61970. This edition of the document was prepared based on Edition 2 of IEC 61850-6 (2009), IEC 61850-7-3 and IEC 61850-7-4 and has been updated to match the forthcoming Edition 2.1. Mapping to other parts of IEC 61850 is incomplete. Mapping has been considered for the CIM classes defined in IEC 61970-301. The mapping to CIM classes defined in IEC 61968-11 and other standards is incomplete.

This document suggests a technical approach by which two of the leading standards for software interoperability that serve the electric utility industry (the Common Information Model, CIM, and the IEC 61850 model) can cooperate in order to enable effective data exchanges between the domains covered by these standards. Both of these standards are maintained by the International Electrotechnical Committee (IEC).

A number of studies and reports have already been produced on the subject of harmonization as listed in the Bibliography.

The work leading to this Technical Specification has considered how exchanges required by commonly understood use cases might be mapped between the standard models in order to determine the harmonizing changes suggested for the relevant models. The report references any papers, reports or other documents that provided data for this harmonization.

The approach is to define a transformation of the data governed by IEC 61850 SCL XSD to data governed by CIM UML. The transformations in this document are defined based on the use cases presented in this document. Only SCL data relevant to these use cases is transformed.

The aim is to allow the development of tools that perform automatic transformation from an SCL instance file into a CIM based instance model that can then be exported using existing standards such as IEC 61970-552: CIMXML Model exchange format.

These transformations will result in CIM-side processes that can distribute the information as needed for configuration of specific CIM applications. It is also presumed that the result of this exchange will be to enable creation of real-time CIM-side clients for IEC 61850 system data.

The heart of the SCL to CIM transformation specification defined in this document is a mapping between the two information models. Wherever this mapping has been judged to be unnecessarily complex, changes have been recommended to the existing information models.