IEC TR 61850-80-5

Edition 2.0 2026-04

TECHNICAL REPORT

Communication networks and systems for power utility automation -
Part 80-5: Guideline for mapping information between IEC 61850 and IEC 61158-15

ICS 33.200

ISBN 978-2-8327-1064-7

IEC TR 61850-80-5:2026-04(en)

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IEC TR 61850-80-5 has been prepared by IEC technical committee 57: Power systems management and associated information exchange. It is a Technical Report.

This second edition cancels and replaces the first edition published in 2024. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) deficiencies / missing text in Edition 1 corrected.

The text of this Technical Report is based on the following documents:

Draft	Report on voting
57/2858/DTR	57/2891/RVDTR

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

The language used for the development of this Technical Report is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

A list of all parts in the IEC 61850 series, published under the general title *Communication networks and systems for power utility automation*, can be found on the IEC website.

NOTE The following print types are used:

– *specific element names from the SCL extension: in italic type.*

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

– reconfirmed,
– withdrawn, or
– revised.

INTRODUCTION

This part of IEC 61850, which is a Technical Report, provides a guideline to exchanging information between IEC 61850 and IEC 61158-6-15 (Modbus TCP). Today, industrial fields, such as distributed energy resource (wind and solar energy, etc.) and condition monitoring, have been successfully exchanging information from Modbus to IEC 61850. Although many manufacturers have already implemented the Modbus to IEC 61850 conversion device or system, these devices do not guarantee interoperability. Therefore, a consistent and unified information exchange scheme between IEC 61850 and IEC 61158-6-15 is required.

Modbus over serial line (Modbus RTU) is not part of IEC 61158-6-15 but is also considered in this technical report.

It was first foreseen to prepare this document as a Technical Specification. However, as there is a lack of feedback from practical experience, it was decided to first publish a Technical Report with a limited scope (see 57/2506/Q and 57/2553/RQ).

This is now the second edition of a Technical Report with the scope including the mapping of a Modbus device's command from an IEC 61850 model.

1 Scope

1.1 General

1.1.1 Scope statement

This part of IEC 61850, which is a Technical Report, specifies the mapping framework for building and configuring a system using both IEC 61850 and IEC 61158-6-15 (Industrial communication networks – Fieldbus specification, CPF Type 15, Modbus) protocols by utilizing gateways between IEC 61850 and IEC 61158-6-15 IEDs / subsystems. The objective is to enable operational run-time data exchange among these IEDs / subsystems, and to automate the configuration of a gateway as much as possible.

Please note that for the purposes of this document, "Modbus" is used to represent both serial Modbus (Modbus RTU) and IEC 61158-6-15 (Modbus TCP).

Within the capability of each protocol, some configuration attributes (IEC 61850-7-3:2010 and IEC 61850-7-3:2010/AMD1:2020 attributes with functional constraint CF) are also mapped in addition to the operational real-time data.

The frameworks specified in this document are based on the published standards and do not make any proposed changes to IEC 61850 or 61158-6-15. This standard does not specify any framework for an IEC 61850 IED to directly communicate with a Modbus IED and vice versa, except through a gateway.

This document does not mandate which data items that a particular IED will be supporting, regardless of whether the implementation uses Modbus or IEC 61850. Instead, this document provides a framework specifying how a gateway maps any given data item from Modbus into an IEC 61850 substation, including the control direction.

Similarly, this document does not mandate which mapping framework a given gateway will be supporting. When this document is republished as a Technical Specification, conformance requirements will be identified.

This document recognizes that there will be situations in which a user will require that a gateway perform non-standard protocol mappings. Non-standard mappings are outside the scope of this document.

This document also recognizes that gateways typically manipulate the data passing through them in a variety of ways. Some of these functions include alarm trigger grouping, data suppression, interlocking and command blocking. Conformance to this document does not preclude a gateway from performing such functions, even though this document primarily specifies "straight through" mapping of Modbus data to IEC 61850-7-3:2010 and IEC 61850-7-3:2010/AMD1:2020 data. Subclause 7.5 of this document describes how some of these functions can be specified to a gateway by a mapping tool using XML representations of conversion functions.

The mapping architecture for the exchange of the run-time information consists of four parts:

a) Conceptual architecture of a gateway and associated use case
b) Mapping of the information model (Assign semantic to the Modbus data)
c) Mapping of the data (which is in fact part of the information model)
d) Mapping of the services (out of scope for this document)

1.1.2 Areas of application

While a primary focus of this document is for electric utility industry, other industries that deliver energy and water could also use this document if they also plan to use both Modbus and IEC 61850 in their systems.

Vendors can use this document to implement and test their gateway products and be assured of their interoperability to this mapping standard. Users can use this document to specify their respective systems. System integrators can use this standard to assist in system integration and testing of user systems utilizing both protocols and gateways.

Modbus device vendors can use this document to express, in a non-ambiguous manner, the semantics of each of the data points exposed over the Modbus interface.

1.1.3 Benefits

This document specifies an SCL extension, using a Modbus specific XML namespace, to add syntax for describing the mapping of Modbus data into the IEC 61850 data model (see Annex A for use of SCL to include Modbus information). By using this specification, Modbus devices can benefit from the full IEC 61850 ecosystem (engineering tools, engineering process, functional naming, …).

This version of the document describes the mapping of data from a Modbus server to be exposed in an IEC 61850 server access point of the gateway. This is intended to enable automated gateway configuration.

1.2 Published versions of this standard and related namespace name

Table 1 provides an overview of the references between the published versions of this standard and the related namespace name.

Table 1 – Reference between published versions of the standard and related namespace name

Edition	Publication date	Webstore	Namespace
Edition 1.0	2024-02	IEC TR 61850-80-5:2024	IEC 61850-80-5:2020A2
Edition 2.0	2025-xx	IEC TR 61850-80-5:2025	IEC 61850-80-5:2020A4

1.3 Namespace name and version

The namespace associated with this document is an XML schema (XSD) for an extension to the System Configuration Language (SCL) as defined in IEC 61850-6. The parameters which are identifying the namespace are provided in Table 2.

Table 2 – Attributes of IEC 61850-80-5 XML namespace

Attribute	Content
Namespace nameplate	
Namespace Identifier (xmlns)	http://www.iec.ch/61850/2020/SCL/80-5
Version	2020
Revision	A
Release	4
XSD version header attribute	2020A4
Recommended reference name	eIEC61850-80-5
CodeComponentName	IEC_61850-80-5.SCL.2020A4.Full
Namespace dependencies	
includes	http://www.iec.ch/61850/2003/SCL version :2007 revision :B release :4

1.4 Code Component distribution

Each Code Component is a ZIP package containing at least the electronic representation of the Code Component itself and a file describing the content of the package (IECManifest.xml).

The life cycle of a code component is not restricted to the life cycle of the related publication. The publication life cycle goes through two stages, Version (corresponding to an edition) and Revision (corresponding to an amendment). A third publication stage (Release) allows publication of Code Component in case of urgent fixes of InterOp Tissues, thus without need to publish an amendment.

Consequently, new release(s) of the Code Component might be released, which supersede(s) the previous release, and will be distributed through the IEC TC57 web site at:

http://www.iec.ch/tc57/supportdocuments.

The latest version/release of the document will be found by selecting the file for the code component with the highest value for VersionStateInfo, e.g. IEC_TR_61850-80-5.SCL.{VersionStateInfo}.full.zip.

The code component associated to this document is an XML schema file (XSD). It is available as a full version only. It is freely accessible on the IEC website for download at http://www.iec.ch/tc57/supportdocuments but the usage remains under the licensing conditions.

In case of any differences between the downloadable code component and the IEC pdf published content, the downloadable code component is the valid one; it can be subject to updates. See included history files.

2 Normative references

There are no normative references in this document.

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

– IEC Electropedia: available at http://www.electropedia.org/

– ISO Online browsing platform: available at http://www.iso.org/obp

3.1.1
Modbus Client
interface which allows the user application to explicitly control information exchange with a remote device

Note 1 to entry: The Modbus Client builds a Modbus request from parameter contained in a demand sent by the user application to the Modbus Client Interface. The Modbus Client uses a Modbus transaction whose management includes waiting for and processing of a Modbus confirmation.

3.1.2
Modbus Server
module which, on reception of a Modbus request, activates a local action to read, to write or to achieve some other actions

Note 1 to entry: The processing of these actions is done totally transparently for the application programmer. The main Modbus server functions are to wait for a Modbus request on 502 TCP port, to treat this request and then to build a Modbus response depending on device context.

3.2 Abbreviated terms

For the purposes of this document, the abbreviated terms given in IEC TS 61850-2, IEC 61850-7-2:2010 and IEC 61850-7-3:2010/AMD1:2020 as well as the following apply.

ICT IED Configuration Tool

MCD Modbus Configuration Description

MCT Modbus Configuration Tool

4 Architecture of gateways between IEC 61850 and Modbus

4.1 Overview

This clause describes the conceptual architecture of gateways between IEC 61850 and Modbus. There are two basic types of gateways to be considered:

– Gateway between an IEC 61850 server IED and a Modbus client IED. This can be the case where the substation with IEC 61850 is connected to the network control center via Modbus communication.

– Gateway between a Modbus server IED and an IEC 61850 client IED. This is the case where a Modbus IED must be connected to a substation using IEC 61850.

This document will focus on the second case, because it is more common. The first case might be treated in a later edition of this document. Nevertheless, the basic principle of both gateway types is described in 4.2 to 4.3.

4.2 Gateway between a Modbus server IED and an IEC 61850 client/subscriber IED

4.2.1 General

The generalized configuration is shown in Figure 1. It consists of several Modbus server devices, a gateway device, and an IEC 61850 client device. One side of the gateway has a Modbus client interface to communicate with the Modbus server devices and the other side of the gateway has an IEC 61850 server interface for communication with the IEC 61850 client/subscriber device. The IEC 61850 communications provided by the gateway are out of scope of this document.

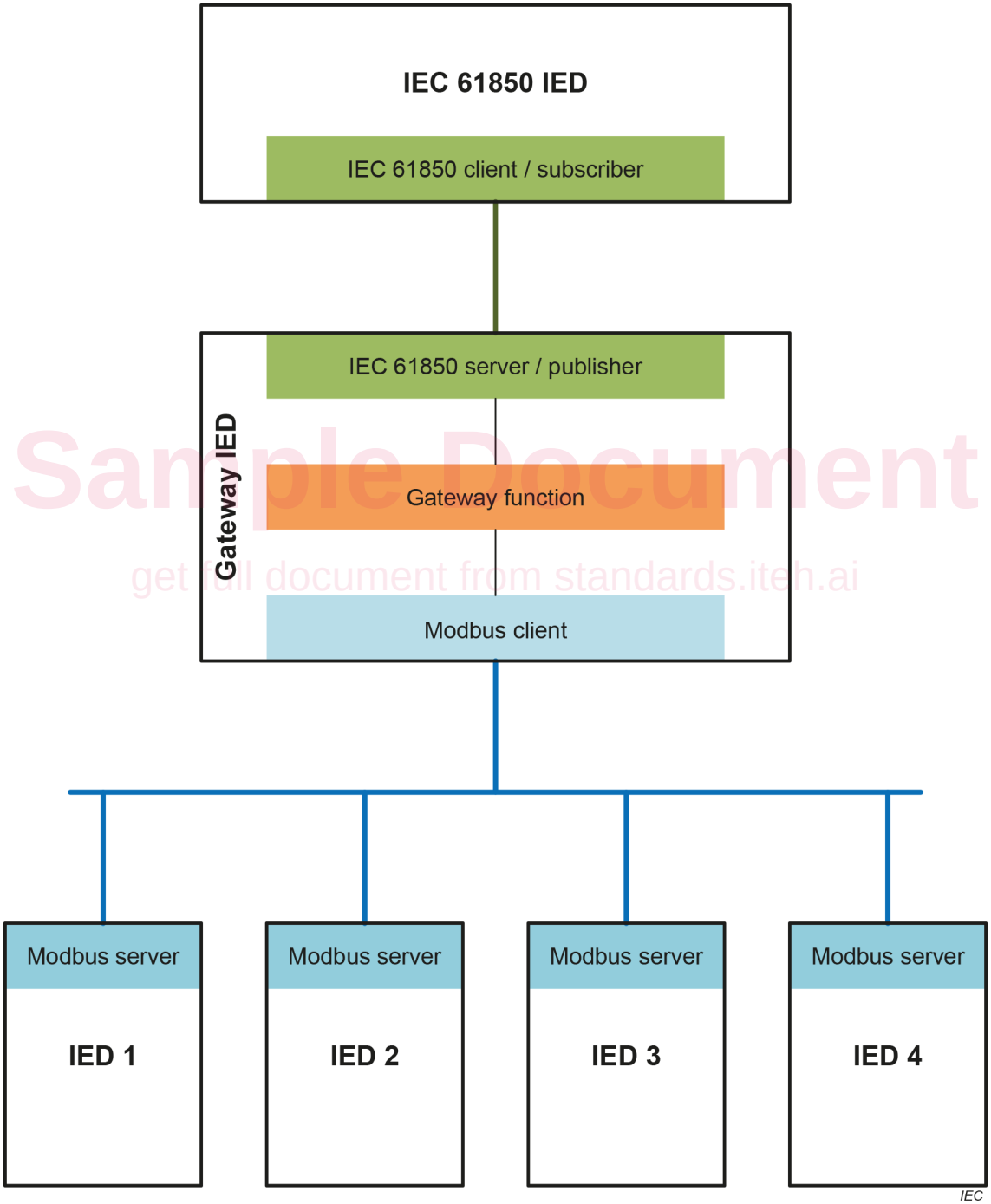

Figure 1 – Communication between Modbus server IEDs and an IEC 61850 client IED

4.2.2 Gateway device

The conceptual architecture of the gateway device is shown in Figure 2. The gateway device is decoupling the IEC 61850 communication and the Modbus communication via a "Gateway function". The Gateway function can implement an IEC 61850 process data image. The advantage of this approach is that a real-time pass-through is not necessarily required for all messages. The following principles are used for the information exchanges between IEC 61850 and Modbus:

– Run-time operational information (status information, measurements) that is usually transmitted event driven is exchanged through the process data image. Data retrieval on the two networks is independent and can take place at different rates.

– Services for the control model interaction are converted and directly forwarded by the gateway. Therefore, these services are supported by the gateway function.

– Run-time access to other information of the data model (parameters, configuration and description information, substitution) is converted and directly forwarded to the Modbus IED by the gateway. Therefore, these services are supported by the gateway function.

– Runtime configuration and substitution information of the data model that are implemented by the IEC 61850 gateway server are not converted nor forwarded to the Modbus IED.

This document defines the way data structures are mapped. The way to map the services is not defined because various implementations of a Modbus service exist in the field. Note that the implementation of the process data image is a local issue. It could be a database, or it could be something else. Internal operations performed by the gateway on the data in the process data image are permitted but are out of the scope of this document.

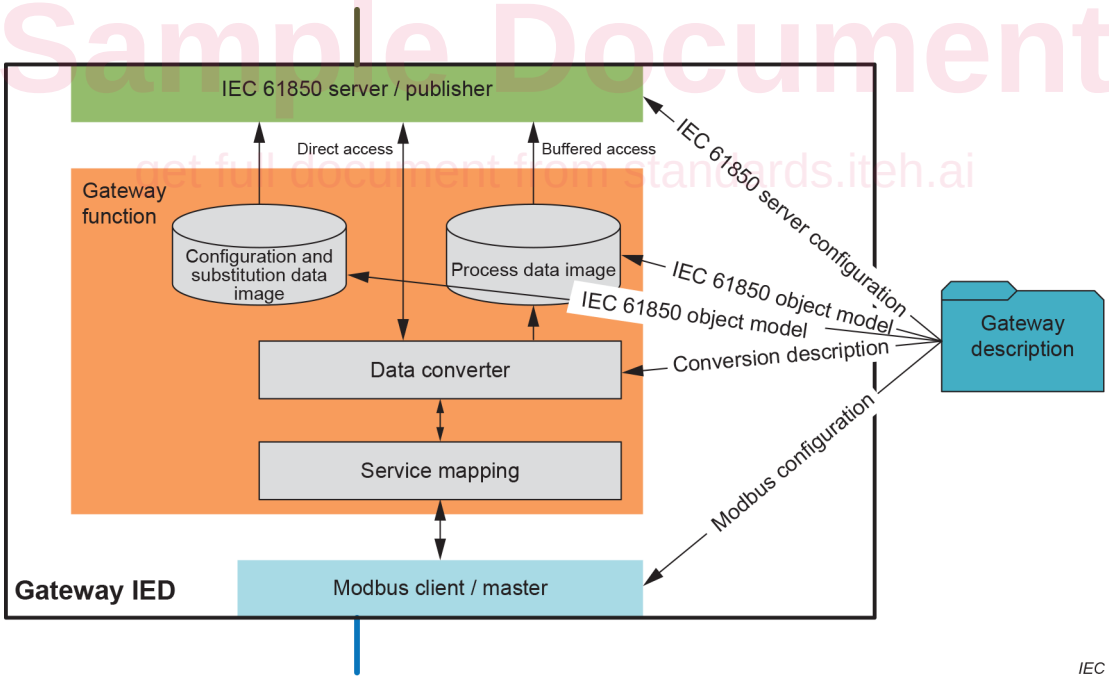

Figure 2 – Architecture of a gateway between Modbus server IEDs and an IEC 61850 client IED

NOTE The term process data image has already been used in IEC 61850-90-2 for the same purpose and is used here for consistency with other parts of IEC 61850.

4.2.3 Handling of communication interruptions between the Gateway Modbus Client and the Modbus Server

4.2.3.1 General

The communication between a Modbus Server IED and the Gateway Modbus Client can be disturbed for various reasons. This will also influence the communication between the Gateway IEC 61850 server and the IEC 61850 Client. Subclauses 4.2.3.2 to 4.2.3.7 define the behaviour of the Gateway IEC 61850 Server.

4.2.3.2 Status and Measurands

If the Gateway maintains a local process data image, the quality of status information and measurands will follow the specifications given in IEC 61850-7-2:2010, Annex D and IEC 61850-7-3:2010/AMD1:2020, Annex D. A GetDataValues request will return the last value received from the Modbus Server IED with the updated status information. A SetDataValues request will result in a ServiceError.

4.2.3.3 Control

When a Modbus Server IED is disconnected from the Gateway Modbus Client, the Gateway IEC 61850 server will respond with a temporarily-unavailable ServiceError to all attempts to control one of the values.

4.2.3.4 Setting Group Control

Setting Group Control is not supported with this edition of the document.

4.2.3.5 Report Control

Reporting, buffered and unbuffered, requires a local process data image. When the communication between the Modbus Server IED and the Gateway Modbus Client is disturbed, the quality of the related data in the local process data image will be changed (see 4.2.3.2). If the trigger option TrgOpt = qchg (quality-change) is set, reports with the updated values will be send to the IEC 61850 client.

The reporting function itself is not influenced by the communication interruption between the Modbus Server IED and the Gateway Modbus Client, because the reports for the IEC 61850 client are created in the Gateway IEC 61850 server.

4.2.3.6 Substitution

Substitution within the Modbus IED is not supported with this edition of the document.

4.2.3.7 File Transfer

File Transfer is not supported with this edition of the document.

4.2.4 Handling of Mod and Beh

IEC 61850 supports the possibility of changing the mode of logical devices or logical nodes by using the data object Mod that might be present in any logical node including in LLN0. Changing any Mod in the Gateway IEC 61850 server follows the specifications for operations in the control direction. All changes of the logical node mode effects only the behaviour of the IEC 61850 server of the Gateway.

This edition of the document does not define any framework how a change of the mode affects the communication between the Gateway Modbus Client and the Modbus Server of the Modbus IED.