

Use of OPC UA in the SITOP environment

<https://support.industry.siemens.com/cs/ww/en/view/109750327>

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Overview

Digitization in the industrial world is marching on under the banner of "Industry 4.0". As well as communication with network participants within an automation level, communication across different levels of automation is becoming more important.

Quick and simple integration of participants into an automation network should prevent unnecessary standstill times and increase production.

The networking, monitoring and diagnosis of automation systems enables the early detection of shutdowns and creates saving potentials. The productivity of the system increases.

The communication protocol OPC UA plays an important role in this.

What is OPC UA and how does it work?

When should OPC UA be used?

How do you activate the OPC UA server in the power supply?

Which potential applications do SITOP products offer for the use of OPC UA?

The following document is intended to provide an insight into various questions and to serve as a guide for applying the communication standard.



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Table of contents

1	Overview
2-3	Warranty and liability
4	Table of contents
5	List of abbreviations
6	Overview of communication protocol OPC UA
6	General information on OPC UA
6	History of OPC
6	Advantages of OPC UA
7-8	SITOP power supply systems with integrated OPC UA server
7	Activation and configuration of the OPC UA server
7	Communication with the OPC UA server
8	Design of the data structure of the OPC UA server
9-12	Potential applications of OPC UA in the SITOP environment
9	Connection to existing, simple OPC UA client application
9	Connection to SCADA systems
10	Developing your own OPC UA applications / programs / clients
10	Connection to energy management systems
11-12	Connection to industrial Cloud solutions
13-14	Additional information
13	SITOP power supplies
13	Service and Support
14	Links and Literature

List of abbreviations

ALM	A utomation L icense M anager
API	A pplication P rogramming I nterfaces
COM	C omponent O bject M odel
DCOM	D istributed C omponent O bject M odel
HMI	H uman M achine I nterface
IEEE	I nstitute of E lectrical and E lectronics E ngineers
OPC	O pen P latform C ommunications
OPC UA	OPC U nified A rchitecture
SCADA	S upervisory C ontrol A nd D ata A cquisition
TCP/IP	T ransmission C ontrol P rotocol (TCP) / I nternet P rotocol
TSN	T ime S ensitive N etworking

Overview of communication protocol OPC UA

General information on OPC UA

The communication standard OPC Unified Architecture (OPC UA) is a protocol for the exchange and delivery of data in an industrial environment. It is based on the TCP/IP protocol. The standard is defined by IEC 62541.

The standard provides a range of services for data exchange, archiving, reporting and method application.

OPC UA has various security measures for secure data exchanges such as user authentication, encryption and signing.

In the year 2006, OPC UA was first used in the field of automation as a test version and was released for industrial use in 2008.

OPC UA is the successor to the communication standard OPC (Open Platform Communications) which came into use in industry as the first uniform industrial communication standard in 1996.

History of OPC

The standards were developed by the OPC Foundation. The OPC Foundation is a non-profit organization dedicated to the development and dissemination of the OPC communication standard in industry.

The organization was founded by a group of renowned companies in the field of automation technology in 1996. The aim was to develop a uniform standard for industrial application. Siemens AG was one of the founding members.

The organization released the OPC communication standard, a protocol based on Microsoft Windows, in 1996. Communication took place via the DCOM/COM interface of Windows and was designed for communication within an automation level. Authentication is via Windows users and groups.

The requirements of machine integration, availability and security grew with technological advances and the demands on the

OPC standard also grew. The standard was revealed to have disadvantages:

- Operating system dependency (Windows)
- Problems in configuring the communication interface DCOM/COM
- Weaknesses in the authentication process
- Outdated security mechanisms

Because of these disadvantages, the OPD Foundation developed the successor version OPC UA.

Advantages of OPC UA

Compared to OPC, OPC UA has the following advantages:

- Vendor and platform-independent.
→ Direct implementation in sensors, controllers, HMIs, ERP systems in all operating systems
- Vertical and horizontal communication between automation levels
→ Interoperability across all levels
→ Direct connection of devices at all Communication levels
- Open and standardized interface
→ Integrated and scalable
→ Clear data integration thanks to integrated, semantic data description
→ Simple and fast connection
- Third-party connectivity (e.g. MES systems)
→ vendor-independent connection of OPC UA-compatible clients
- Reliable and proven security concept
→ Authentication and signature of messages
→ Encryption of messages
- Parallel communication on a data line with PROFINET based on TCP/IP

The OPC UA standard had defective real-time communication (transfer speed, no deterministic/ synchronous communication).

Because of this, from 2012 to 2016, the OPC Foundation worked on an IEEE-Standard TSN (Time Sensitive Networking) extension of the protocol which enables a real-time data transfer via ethernet.

SITOP power supply systems with integrated OPC UA server

With the modular power supply SITOP PSU8600 (from firmware V1.2.0) and the uninterruptible power supply SITOP UPS1600 (from firmware V2.2.0), Siemens AG offers to power supply systems with an integrated OPC UA server. This supplies device data and services. Both are fully integrated in the TIA portal and PROFINET-compatible.



Figure 1: SITOP power supply systems with integrated OPC UA server

Activation and configuration of the OPC UA server

The OPC UA server is activated for both power supply systems as standard.

The OPC UA server is deactivated via the respective integrated web server during normal power supply operation.



Figure 2: Switch and rotary coding switch setting to activate the web server

To activate the web server of the SITOP PSU8600, the "WEN" dip switch must be in the "ON" position (move the switch to the right).

The web server starts automatically when the device is restarted.

The principle is similar for the SITOP UPS1600. Switch the rotary coding switches "V_{THR}" and "t_B" on the front of the housing to "REN" and "OFF". If the web server is temporarily activated, you can permanently activate it in the settings.

For remote operation of the SITOP PSU8600, the dip switch "REN" must be in the "ON" position, for the SITOP UPS1600, the "V_{THR}" rotary coding switch must be in the "REN" position.

In remote operation, the OPC UA server is configured in the hardware configuration in SIMATIC Manager with STEP 7 / STEP 7 Professional or TIA Portal STEP 7 Basic / STEP 7 Professional and is (de)activated by loading the hardware configuration.

Both the web server and the hardware configuration offer a wider range of configuration options for the OPC UA server:

- Change of OPC UA server port number
- (De)activation of unencrypted access
- User configuration for OPC UA servers

Communication with the OPC UA server

The OPC UA server for OPC UA clients can be found on the associated end point URL "opc.tcp\\<ip-address>:<OPC UA server port number>". The end point URL is made up of the end point type "opc.tcp://" for OPC UA via TCP/IP, the IP address of the power supply and the port number of the OPC UA server.

The OPC UA communication standard contains the security mechanisms:

- Authentication and authorization
- Encryption and data integrity through signature

For "authentication and authorization" on the server, the user must have sufficient rights. The user administration and rights assignment is regulated via the hardware configuration (HW configuration > PROFINET-security) of the web server.

The type of data transfer ("encryption and data integrity by signature") is defined by the message security mode and the security policy .

There are three possible message security modes:

- None (not signed and encrypted)
- Sign (signed)
- Sign & Encrypt (signed and encrypted)

The security policy defines the type of encryption:

- None (not encrypted)
- Basic128Rsa15
- Basic256
- Basic256Sha256

Digital authentication takes place via a certificate exchange between OPC UA client and OPC UA server.

The certificate also enables the encryption and signature of data packets.

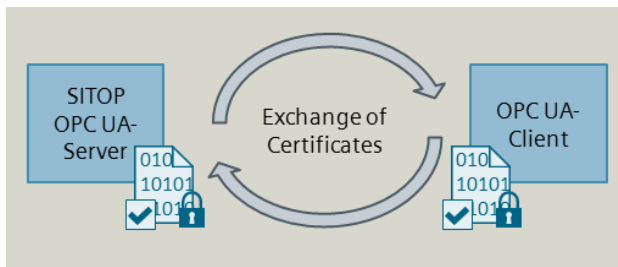


Figure 3: Certificate exchange between server and client

The encrypted and digitally signed connection is set up after examination by the communication partners (server and client).

The OPC UA server has its own integrated certificate administration. Windows-based OPC UA clients use Windows certificate administration.

Design of the data structure of the OPC UA server

The device data and services are arranged as a tree structure in the OPC UA address space (namespace). They are designated as nodes. The OPC UA server determines the Write and Read rights.

Each node belongs to a certain node class.

There are different types of node class:

- Data type ("dataType")
- Method
- Object
- Object type ("ObjectType")
- Reference type ("ReferenceType")
- Variable
- Variable type ("VariableType")
- View

Variables display the device data of the power supplies and allow Read / Write.

Using various methods, the OPC UA server provides write and control commands for frequently required application scenarios.

In addition, each of the nodes receives a node name which is fixed by the OPC UA server and cannot be changed ("BrowseName").

The relevant node names can be found in the SITOP UPS1600 and PSU8600 manuals.

The node name can be used to determine the node ID ("NodeID") which assigns a clear address for a node in the OPC UA address space. You can write device data and execute methods via the node name.

The OPC UA server generates the NodeID independently of the hardware configuration and firmware of the power supply.

The node ID consists of three components:

- Index for the address space ("NamespaceIndex")
- Type of identifier ("IdentifierType")

There are three types of identifier:

- String (text identifier)
- Numeric (numerical identifier)
- GUID (global unique identifier assigned by the OPC Foundation)
- Identifier for the attribute ("Identifier")

The identifier type is independent of the parametrization of the OPC UA server. With the SITOP PSU8600 and UPS1600, a numerical identifier is always used for the attributes.

Nodes can also have other attributes. The list of attributes is set by the OPC UA server and cannot be changed.

For further technical information, refer to the respective SITOP power supply system manuals:

<https://support.industry.siemens.com/cs/ww/en/ps/18018/man>

Potential applications of OPC UA in the SITOP environment

The potential applications of SITOP UPS1600 and PSU8600 OPC UA servers are wide-ranging due to the standardization and the many advantages that OPC UA offers. With OPC clients, data exchange can take place in a variety of ways. The following are conceivable in this context:

- Simple OPC UA client applications
- HMI and SCADA systems
- Custom OPC UA applications
- Energy management systems
- Cloud solutions

A selection of the most important potential applications is considered below.

Connection to existing, simple OPC UA client application

There are already a large number of existing OPC UA applications which can communicate with the OPC UA server of the power supplies. Two OPC UA browsers can be named here as examples:

- SIMATIC NET OPC Scout
(SIMATIC NET - Siemens AG
<https://www.siemens.com/simatic-net>)
- OPC UA Expert
(Freeware - Unified Automation GmbH
<https://www.unified-automation.com>)

Due to the autonomy and cohesion, these applications do not offer interfaces for other programs nor do they offer data exchange and export capabilities. These limitations are also evident in the display options and extended operability.

Therefore, they are often used as test clients for analyzing OPC UA server structures and functions and to read and write individual data sets and methods.

Connection to SCADA systems

Many HMI and SCADA systems already offer a range of OPC functionalities, including OPC UA clients for data exchanges with OPC UA servers. The following can be given as examples for HMI systems:

- SIMATIC Comfort and Mobile Panels (> V13.0 available)
- SIMATIC WinCC (Runtime) Advanced (>V13.0 available)

The OPC UA clients of the HMI systems offer no user authentication capability. Therefore, data exchange with the OPC UA server of the SITOP power supplies is not possible.

The following can be named as examples for SCADA systems:

- SIMATIC WinCC (Runtime) Professional (\geq V14 SP1)
- SIMATIC WinCC V7.x (\geq 7.4)

SCADA-System SIMATIC WinCC Professional

With V14 SP1, SIMATIC WinCC Professional offers an OPC UA client via the "OPC UA" communication channel. The channel allows a signed, encrypted connection. User authentication is not possible.

With the V15, the channel was enhanced with a user authentication capability and can be used for communication with the SITOP power supplies.

An OPC UA connection with the "OPC UA" communication channel is created and the connection settings are configured in the "HMI Connections" editor.

In the variable editor, the variables can be connected directly with the OPC UA data.

SCADA-System SIMATIC WinCC V7.x

The SCADA system SIMATIC WinCC V7.x offers the communication channel "OPC UA WinCC Channel" for communication with an OPC UA server.

The connection settings are configured using the connection parameters.

The variables are connected with the OPC UA data in the "Variable Maintenance" editor.

The data can be processed and visualized in the SCADA systems. The communication limitations for OPC UA must be observed.

Further information on the SCADA systems "SIMATIC WinCC" and "SIMATIC WinCC Professional" can be found on the relevant topic page "SIMATIC WinCC in Online Support":
<https://support.industry.siemens.com/cs/ww/en/view/93906404>

SCADA systems from third parties

Visualization systems from third parties can also be connected to the OPC UA server of the power supplies. A precondition is the implementation of the OPC UA functionalities according to the standards of the OPC Foundation. The client must support the functionalities "signing and encrypting" and "user authentication".

Further information is provided by the respective providers.

Developing custom OPC UA applications -Programs / -Clients

Alternatively, the OPC UA user can program a custom OPC UA application. This means that a connection to higher systems (MES/ERP systems) can be implemented to evaluate data from the automation system.

For application development, the OPC Foundation provides so-called "Application Programming Interfaces (APIs)". The following programming languages are supported, among others:

- C
- C++
- C# (.NET)
- Java

The APIs give the programmer various functions for Write and Read accesses to the server, as well as creating connections with the server. These functions simplify application development and reduce development time.

For example, Microsoft Visual Studio Professional (2010 onwards) enables the programming of an Excel-C# application. The precondition for this is a .NET-Framework 4.0. Using a suitable .Net-API, you can program your own OPC UA client, which reads defined data, writes it to an Excel

list and updates it.

Write commands and method calls are possible with Windows Forms elements.

The Application Example "OPC UA .NET client for the SIMATIC S7-1500 OPC UA server" provides an example of how to develop a custom OPC UA application.
<https://support.industry.siemens.com/cs/ww/en/view/109737901>

Connection to energy management systems

Energy costs have increased significantly over the last few years. These are huge costs for businesses. This makes the transparency of a system's energy consumption ever more important.

Siemens AG offers several energy management systems for the monitoring, analysis and evaluation of the energy and operational data of a system:

- SIMATIC Energy Suite (≥ TIA Portal V14)
- SIMATIC Energy Manager PRO

SIMATIC Energy Suite

The "SIMATIC Energy Suite" is acquired as an additional packet for TIA Portal and facilitates the monitoring and provision of energy objects (current, consumed performance and energy, periodic mean of performance and energy). The energy objects are embedded in the control program.

Licensing occurs via the number of energy objects in the 5x or 10x license packets. An extensive analysis of the energy data is not performed automatically, but must be triggered by the control program or HMI/SCADA system.

An OPC UA connection to an OPC UA server of SITOP power supplies can be created on the OPC UA channel of the SCADA systems.

SIMATIC Energy Manager PRO

The "SIMATIC Energy Manager PRO" offers additional capabilities compared to "SIMATIC Energy Suite". It is an independent program and therefore independent of the control program.

It offers efficient monitoring and recording of energy and operational data as well as flexible analysis and evaluation functions. A comprehensive reporting facility is integrated as an additional function. Reports can be exported for analysis.

Communication with the system is safeguarded by an integrated OPC UA interface. This makes it possible to connect the SITOP power supplies without a problem.

For local and decentral access without a browser, Siemens AG offers the "SIMATIC Energie Manager PRO Client". This is installed on the client computer.

The licensing is independent of the number of clients connected to the server and occurs via the "Automation License Manager (ALM)" which is installed with the "SIMATIC Energy Manager PRO".

For browser-supported and mobile access via the internet / intranet / network, the energy management system offers the option "SIMATIC Energy Manager PRO Web", a browser-supported user interface.

An additional license for client access must be acquired for the use of the function. The license depends on the number of connected web clients and is also activated in "ALM".

Further information on the energy management systems can be found on the relevant topic page "Energy Management with SIMATIC in Industry Online Support": <https://support.industry.siemens.com/cs/ww/en/view/68043160>

[Connection to industrial Cloud solutions](#)

Cloud solutions play an ever-increasing role in digitization. Data management in the Cloud can, for example, provide access to the data for a production system over the internet around the clock and from anywhere in the world. This helps monitor production systems more efficiently and can react more efficiently to changes.

Historical data are stored in the Cloud, as well as current production data. This enables data evaluations over longer periods of time; for example, to evaluate the energy consumption of your system.

[Overview of Cloud solution "MindSphere"](#)

Since 2017, Siemens AG has provided the Cloud solution "MindSphere" for industry.

The Cloud provides an OPC UA interface for the connection of OPC UA-compatible devices. An interface for the S7 protocol is also integrated.

This helps you connect the devices of your production system with the Cloud in just a few steps. A device with a standardized OPC UA server is required for the OPC UA connection. The Cloud functions as an OPC UA client.

Energy data, for example, are sent across the connection to the Cloud as data points (aspects). This takes place at defined time intervals.

The Cloud saves the data and evaluates it according to user-defined rules.

[Requirements for the use of the Cloud solution "MindSphere"](#)

For the OPC UA connection, you need additional hardware between your SITOP power supplies and the Cloud solution "MindSphere", namely, a device compatible with "MindConnect" or "MindSphere".



Figure 4: Hardware for the OPC UA connection with the MindSphere

Available "MindConnect" devices are:

- MindConnect Nano
- MindConnect IoT2040

Available "MindSphere"-compatible devices are:

- RUGGEDCOM RX1400

The system network and an internet connection is connected to the device.

The device automatically assumes the separation of the networks and registration to and communication with the Cloud. The software on the device enables encrypted data transfer in the Cloud.

Along with the additional hardware, an account ("Tenant") is required for the administration of the connected systems, services, as well as users and user rights. Login is via a web interface and can be performed with any browser.

Each device is connected as a data source. Multiple data sources can be grouped into an "Asset". These Assets are then given a unique ID ("Asset-ID") for referencing, to run targeted analyses or reports.

Each account can have several users with different rights. The rights depend on the type of user. There are two types of users:

- Administrator ("TenantAdmin")
- Default User ("StandardUser ")

Additionally purchased packages ("MindApps") can implement additional user roles.

Administrators have the right to create and manage users and systems and can use all services approved for the account.

Standard users can only see the systems enabled for them and are limited to the use of their own services.

Evaluation potential of the Cloud solution "MindSphere"

The Cloud solution offers a wide range of data evaluation and report creation options:

- Displaying data transparently
- Calculating KPIs
- Monitoring operating times and availability
- Monitoring limits
- Generating alarms and messages
- Generating automatic notifications
- Generating custom views for reporting

The functionalities are provided via the services ("MindApps"). There are cost-free and cost-bearing services. These can be added or removed from the account at any time.

The Cloud offers an open programming interface and a scalable development environment for the development of custom MindApps. This service can be added at any-time and is cost-bearing (per user), but is only available to administrators.

You can find more information on the "MindSphere" Cloud solution on the corresponding home page:
<https://siemens.com/mindsphere>

Additional information

SITOP power supply systems

Market Portal

On our Market Portal for SITOP, you can find comprehensive information on our range of solutions for the automation sector:

<https://www.siemens.com/sitop>

Important documents and links for SITOP

The SITOP topic page offers an overview of the key documents and links for SITOP power supplies:

<https://support.industry.siemens.com/cs/ww/en/view/109748829>

Both beginners and experienced users can find the perfect introduction to the key information here.

Contact partner

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<https://support.industry.siemens.com/cs/sc>

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You will receive optimum support wherever you are with the "Siemens Industry Online Support" app. The app is available for Apple iOS, Android and Windows Phone:

<https://support.industry.siemens.com/cs/ww/en/sc/2067>

Links and Literature

- 11) Siemens Industry Online Support
<https://support.industry.siemens.com>
- 12) Link to the entry page of the white paper
<https://support.industry.siemens.com/cs/ww/en/view/109750327>
- 13) SITOP Market Portal
<https://www.siemens.com/sitop>
- 14) OPC Foundation
<https://opcfoundation.org/>
- 15) Manual "Power supply system SITOP PSU8600-basic device with four outputs", Chapter "Engineering and Remote Access > OPC UA Server"
<https://support.industry.siemens.com/cs/ww/en/view/105867947/94918395915>
- 16) Manual "Power supply system SITOP PSU8600-basic device with one output", Chapter "Engineering and Remote Access > OPC UA Server"
<https://support.industry.siemens.com/cs/ww/en/view/109482936/95695450763>
- 17) Manual "Uninterrupted power supply SITOP UPS1600 / UPS1100", Chapter "Engineering and Remote Access > OPC UA Server"
<https://support.industry.siemens.com/cs/ww/en/view/84977415/99561768715>
- 18) SIMATIC NET
<https://www.siemens.com/simatic-net>
- 19) Unified Automation GmbH
<https://www.unified-automation.com>
- 110) Application Example "Communication over OPC UA with SIMATIC HMI systems (Comfort Panels, Runtime Advanced, Runtime Professional)"
<https://support.industry.siemens.com/cs/ww/en/view/63481236>
- 111) Topic page "SIMATIC WinCC in Online Support"
<https://support.industry.siemens.com/cs/ww/en/view/93906404>
- 112) Application Example "OPC UA Client Library"
<https://support.industry.siemens.com/cs/ww/en/view/109748892>
- 113) Application Example "OPC UA .NET client for the SIMATIC S7-1500 OPC UA server"
<https://support.industry.siemens.com/cs/ww/en/view/109737901>
- 114) Application Example "Programming of an OPC UA .NET client C# for the SIMATIC NET OPC UA Server"
<https://support.industry.siemens.com/cs/ww/en/view/42014088>
- 115) Topic page "Energy Management with SIMATIC in Industry Online Support"
<https://support.industry.siemens.com/cs/ww/en/view/68043160>
- 116) MindSphere
<https://siemens.com/mindsphere>