



OPC Unified Architecture (OPC UA)

API DESCRIPTION



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Perfect Welding / Technical Product Management

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1 Introduction

The Open Platform Communications Unified Architecture (OPC UA) is a platform independent service-oriented architecture that integrates the functionality of the individual OPC classic specifications into one extensible framework. It was developed by the OPC Foundation and first released in 2008. OPC UA differs significantly from its predecessor OPC and was designed to support the needs of industrial automation.

This document describes the implementation of the OPC UA server within the FRONIUS TPS/i and WeldCube Connector.

The objects described in chapter 2 reference the following minimum firmware versions:

TPS/i 3.2.10

WeldCube Connector: 1.3.0ö

1.1 What is OPC UA and what is it used for

OPC UA is one of the most used communication protocols for industrial automation. It is a platform-independent and service-oriented architecture specification that integrates all functionality from the existing OPC Classic specifications, providing a migration path to a more secure and scalable solution. The specification is backwards compatible with OPC Classic. It is designed for machine-to-machine communications.

The implementation of OPC UA server in FRONIUS TPS/i welding machines and WeldCube Connector is based on the open-source project **open62541** (<https://www.open62541.org>) for OPC UA server and is licensed under the Mozilla Public License v2.0.

The main characteristics for OPC UA are:

- ➔ Development for industrial communication, data collection and control
- ➔ Open source freely available and implementation under GPL 2.0 license
- ➔ Service-oriented architecture (SOA)
- ➔ State-of-the-art security concept
- ➔ Cross-platform availability

Terminology and description:

- ➔ **Server:** an OPC UA server (e.g. welding machine) provides data
- ➔ **Client:** an OPC UA client (e.g. MES connector) requests or writes data from or to a server
- ➔ **Object:** nodes are organized in objects (see object description)
- ➔ **Node:** data node for data access (DA) read and write (see object description)

1.2 Communication protocol

Fronius TPS/i and WeldCube Connector are using a TCP-based **binary communication** over **opc.tcp** (TCP port 4840) as this implementation is fast, reliable, secure and optimized for embedded devices. Web-Access via http or https (SOAP) and XML web services are not implemented.

1.3 Disclaimer

Although OPC UA is known as reliable and depending on the implementation as fast, the use of OPC UA with FRONIUS welding machines is only for documentation, visualization and informative purposes.

It is not allowed to use any status information provided by this communication for safety implementations.

2 Description of objects and nodes

OPC UA is organized in structured objects. All objects contain one or more nodes for data access (DA). This chapter describes the implemented objects and nodes including data types and enumeration values.

2.1 Objects and nodes for TPS/i

2.1.1 Object: ACTUAL

The following nodes are available during the welding process with the minimum sampling interval of 0.1 seconds. The values can be used to record the weld process data. All nodes of ACTUAL are **read only**.

Node	Type	Unit	Description
ACTUAL_CURRENT	Float [-5000.0...5000.0]	[A]	Current
ACTUAL_VOLTAGE	Float [-500.0...500.0]	[V]	Voltage
ACTUAL_WFS	Float [-99.9...99.9]	[m/min]	Wire feed speed
ACTUAL_POWER	Float [-0.000...1000000.000]	[W]	Power
ACTUAL_WELDINGTIME	Float [0.0...1000000.0]	[s]	Welding time
ACTUAL_GASFLOW	Float [0.0...100.0]	[l/min]	Gasflow
WIREBUFFER_VALUE	Float [-100...100]	[%]	Status of Wirebuffer (100% Full / -100% Empty)

The following topics can be used for external displays and other visualization. The values for current, voltage, wire feed speed, power and energy are automatically set to the state of the welding process.

Node	Type	Unit	Description
DISPLAY_STATUS	Enum 0 [HOLD] 1 [REAL] 2 [COMMAND]	N/A	Status of weld
DISPLAY_CURRENT	Float [-5000.0...5000.0]	[A]	Current
DISPLAY_VOLTAGE	Float [-500.0...500.0]	[V]	Voltage
DISPLAY_WFS	Float [-99.9...99.9]	[m/min]	Wire feed speed
DISPLAY_POWER	Float [0.000...1000000.000]	[kW]	Power
DISPLAY_ENERGY	Float [0.000...0.999]	[kJ]	Energy

2.1.2 Object: JOB

The JOB nodes are related to jobs and represent the actual state and number. For details on the specific settings of the selected job refer to 2.1.6 Object: SETTINGS. The nodes of JOB are writeable.

Node	Type	Unit	Description
JOBNUMBER	UInt16 [1...1000]	N/A	Job number
JOBMODE	bool [TRUE/FALSE]	N/A	Job Mode
JOBREVISION	UInt16 [0...65535]	N/A	Job Revision
JOBSLOPE	Float [0.0...10.0]	[s]	Job Slope
JOBNAME	String [30]	N/A	Job Name

Note: If "JOBMODE" is "FALSE" the "JOBNUMBER" is not representative.

2.1.3 Object: SYSTEM

The SYSTEM nodes represent the actual system state of the welding machine including machine serial number, hour meters and information on the cooler if there is one installed. The values are published on change or update. SYSTEM nodes are **read-only**.

Topic	Type	Unit	Description
SERIALNUMBER	string [100]	N/A	Machine serial number
APIVERSION	string [100]	N/A	MQTT API version
FIRMWAREVERSION	string [100]	N/A	Firmware version of welding machine
TOTAL_CURRENTFLOWTIME	float [0.0...1000000.0]	[h]	Hour-meter current flow time
TOTAL_POWERONTIME	float [0.0...1000000.0]	[h]	Hour-meter power on time of machine
TOTAL_WIRELENGTH	float [0.0...1000000.0]	[m]	Total wire length consumption
TOTAL_SHIELDING_GAS	float [0.0...1000000.0]	[l]	Total shielding gas consumption
COOLER_MODE	enum 0 [AUTO] 1 [ECO] 2 [ON] 3 [OFF]	N/A	Cooler mode
COOLER_TEMP	float [-200.0...200.0]	[°C]	Cooler temperature
COOLER_FLOW	float [-100.00...100.00]	[l/min]	Cooling circuit flow rate
MOTOR_FORCE_M1	float [0...999]	[N]	Motor Force (Motor 1)
MOTOR_FORCE_M2	float [0...999]	[N]	Motor Force (Motor 2)
MOTOR_FORCE_M3	float [0...999]	[N]	Motor Force (Motor 3)

2.1.4 Object: PROCESS

The PROCESS nodes represent the status of the actual process. All nodes of PROCESS are **read-only**.

Topic	Type	Unit	Description
PROCESS_ACTIVE	bool [TRUE/FALSE]	N/A	Process active
PROCESS_MAINPHASE	bool [TRUE/FALSE]	N/A	Process main phase
CURRENTFLOW	bool [TRUE/FALSE]	N/A	Current flow
ARCSTABLE	bool [TRUE/FALSE]	N/A	Arc stable
ERROR	uint16 [0...65535]	N/A	Welding Error (0=OK, No error)
SAFETY_STATUS	Enum 0 [INVALID] 1 [ACTIVE] 2 [SELFTEST] 3 [HALT] 4 [STOP]	N/A	Safety status
PENETRATION_STABILIZER_STATUS	ENUM 0 [INVALID] 1 [OFF] 2 [ON]	N/A	Status of penetration stabilizer
ARC_LENGTH_STABILIZER_STATUS	ENUM 0 [INVALID] 1 [OFF] 2 [ON]	N/A	Status of arc length stabilizer
WIREEND_VALUE	ENUM 0 [INVALID] 1 [OFF] 2 [ON]	N/A	Wire end status
WIRE_END_VALUE_DRUM	ENUM 0 [INVALID] 1 [OFF] 2 [ON]	N/A	Wire end status of drum sensor
WIRE_END_VALUE_RINGSENSOR	ENUM 0 [INVALID] 1 [OFF] 2 [ON]	N/A	Wire end status of ring sensor

2.1.5 Object: TRACE

The TRACE nodes represent the traceability parameters for the actual or next weld. All nodes for TRACE are **writeable** at any time. Please ensure to set those parameters BEFORE starting the weld process.

Topic	Type	Unit	Description
PARTITEMNUMBER	string [100]	N/A	Item/Article number of part
PARTSERIALNUMBER	string [100]	N/A	Serial number of part
SEAMNUMBER	uint16 [0...65535]	N/A	Seam number (or processing step)
PARVERSION	string [100]	N/A	Version of part

Note: To set the traceability parameter you can also use the **FRONIUS Data Channel (TCP)** and/or robot interface.

2.1.6 Object: SETTINGS

The SETTINGS topics represent the actual welding parameter settings including welding mode and trigger mode. If not using JOBMODE those nodes are **writeable**.

Topic	Type	Unit	Description
WELDING_MODE	Enum 0 [MIG_PULS] 1 [MIG_STANDARD] 2 [MIG_STANDARD_MANUAL] 3 [MIG_LSC] 4 [MIG_PMC] 5 [MIG_CMT]	N/A	Welding mode
TRIGGER_MODE	Enum 0 [2_STEP] 1 [4_STEP] 2 [S2_STEP] 3 [S4_STEP] 4 [SPOT]	N/A	Trigger mode
CURRENT_RECOMMVALUE	float [-5000...5000]	[A]	Current recommend value
VOLTAGE_RECOMMVALUE	float [-500.0...500.0]	[V]	Voltage recommend value
WFS_COMMANDVALUE	float [0.0...100.0]	[m/min]	Wire feed speed command value
START_ARCLENGTH_CORRECTION	float [-10.0...10.0]	N/A	Start arc length correction
END_ARCLENGTH_CORRECTION	float [-10.0...10.0]	N/A	End arc length correction
START_CURRENT_TIME	float [0.0...10.0] / [OFF]	[s]	Start current time
END_CURRENT_TIME	float [0.0...10.0] / [OFF]	[s]	End current time
START_CURRENT	uint16 [0..200]	[%]	Start current
END_CURRENT	uint16 [0..200]	[%]	End current
GASPREFLOW	float [0.0...9.9]	[s]	Gas preflow
GASPOSTFLOW	float [0.0...60.0]	[s]	Gas postflow
ARCLENGTH_CORRECTION	float [-10.0...10.0]	N/A	Arc length correction
PULSDYNAMIC_CORRECTION	float [-10.0...10.0]	N/A	Puls dynamic correction
PENETRATION_STABILIZER	float [-10.0...10.0]	[m/min]	Penetration stabilizer
ARC_LENGTH_STABILIZER	float [0.0...5.0]	N/A	Arc length stabilizer
SLOPE_1	float [0.0...9.9]	[s]	Slope 1
SLOPE_2	float [0.0...9.9]	[s]	Slope 2
GASVALUE	float [0.5...30.0] / [AUTO]	[l/min]	Gas command value (or "AUTO")
GASFACOR	float [0.90...20.00]	N/A	Gas factor
SFI	bool [TRUE/FALSE]	N/A	SFI
SFI_HOTSTART	float [0.00...2.00] / [OFF]	[s]	SFI hot start
SYNCHROPULSE_ENABLE	bool [TRUE/FALSE]	N/A	Synchropulse: Enable
SYNCHROPULSE_FREQUENCY	float [0.5...10.0]	[Hz]	Synchropulse: Frequency
SYNCHROPULSE_DELTA_FEEDER	float [0.1...6.0]	[m/min]	Synchropulse: Delta feeder
SYNCHROPULSE_DUTYCYCLE	float [10...90]	[%]	Synchropulse: Duty cycle
SYNCHROPULSE_ARCLENGTH_CORR_HIGH	float [-10.0...10.0]	N/A	Synchropulse: Arc length correction high
SYNCHROPULSE_ARCLENGTH_CORR_LOW	float [-10.0...10.0]	N/A	Synchropulse: Arc length correction low

2.2 Objects and nodes for WeldCube Connector

2.2.1 Object: ACTUAL

The following nodes are available during the welding process with the minimum sampling interval of 0.1 seconds. The values can be used to record the weld process data. All nodes of ACTUAL are **read only**. Wire feed speed is only available for WeldCube Connector U/I/WFS.

Node	Type	Unit	Description
ACTUAL_CURRENT	Float [-5000.0...5000.0]	[A]	Current
ACTUAL_VOLTAGE	Float [-500.0...500.0]	[V]	Voltage
ACTUAL_WFS	Float [-99.9...99.9]	[m/min]	Wire feed speed
ACTUAL_POWER	Float [-0.000...1000000.000]	[W]	Power
ACTUAL_WELDINGTIME	Float [0.0...1000000.0]	[s]	Welding time

2.2.2 Object: SYSTEM

The SYSTEM nodes represent the actual system state of the welding machine including machine serial number, hour meters and information on the cooler if there is one installed. The values are published on change or update. SYSTEM nodes are **read-only**. TOTAL_WIRELENGTH is only available for WeldCube Connector U/I/WFS.

Topic	Type	Unit	Description
SERIALNUMBER	string [100]	N/A	Machine serial number
APIVERSION	string [100]	N/A	MQTT API version
FIRMWAREVERSION	string [100]	N/A	Firmware version of welding machine
TOTAL_CURRENTFLOWTIME	float [0.0...1000000.0]	[h]	Hour-meter current flow time
TOTAL_POWERONTIME	float [0.0...1000000.0]	[h]	Hour-meter power on time of machine
TOTAL_WIRELENGTH	float [0.0...1000000.0]	[m]	Total wire length consumption

2.2.3 Object: PROCESS

The PROCESS nodes represent the status of the actual process. All nodes of PROCESS are **read-only**.

Topic	Type	Unit	Description
PROCESS_ACTIVE	bool [TRUE/FALSE]	N/A	Process active
CURRENTFLOW	bool [TRUE/FALSE]	N/A	Current flow
ERROR	uint16 [0...65535]	N/A	Welding Error (0=OK, No error)
SAFETY_STATUS	Enum 0 [INVALID] 1 [ACTIVE] 2 [SELFTTEST] 3 [HALT] 4 [STOP]	N/A	Safety status

2.2.4 Object: TRACE

The TRACE nodes represent the traceability parameters for the actual or next weld. All nodes for TRACE are **writeable** at any time. Please ensure to set those parameters BEFORE starting the weld process.

Topic	Type	Unit	Description
PARTITEMNUMBER	string [100]	N/A	Item/Article number of part
PARTSERIALNUMBER	string [100]	N/A	Serial number of part
SEAMNUMBER	uint16 [0...65535]	N/A	Seam number (or processing step)
PARVERSION	string [100]	N/A	Version of part

Note: To set the traceability parameter you can also use the **FRONIUS Data Channel (TCP)** and/or robot interface.

3 Setup and Installation

The configuration page for OPC UA setup is located in the SmartManager (welding system website) under the topic “Power Source Settings”. Note: The settings for OPC UA are not affected on backup and restore of FRONIUS welding machines.

The screenshot shows the 'Power source settings' page in the SmartManager interface. The 'OPC-UA settings' tab is active. The 'OPC-UA server' checkbox is checked. The 'Manual selection of Jobnumber' checkbox is unchecked. Under 'Security', the 'Security policy' dropdown is set to 'none'. Under 'Authentication', the 'None' radio button is selected. At the bottom, there are buttons for 'Delete adjustments' and 'Save adjustments'.

OPC UA Settings

- ➔ Enable/Disable: Enable or disable OPC UA server

Security

- ➔ Security policy: Select security policy
- ➔ Server certificate: Upload server certificate
- ➔ Server private key: Upload server private key

Authentication

- ➔ None: Do not use username/password for authentication
- ➔ Username: Username for authentication
- ➔ Password: Password for authentication

3.1 Enable/Disable OPC UA server

By using the enable/disable flag of the checkbox the OPC UA server for the welding machine can be enabled or disabled in general. Disabling the server will break all open connections to the welding machine.

3.2 Security settings

Without any authentication and certificate OPC UA will work in anonymous mode. By using username and password the access on the objects can be restricted. To encrypt the communication between server and client you can use a server certificate and a server private key.

The security policy can be set to:

- ➔ None
- ➔ Basic128RSA15
- ➔ Basic256SHA256

Please note that it is not recommended to use authentication by username and password without encryption.

No authentication and no encryption should only be used in experimental stage.

3.3 Sampling rate

For actual values for **current**, **voltage**, **wire feeder speed** (wfs) and **power** it is possible to setup the sampling rate for publishing. The sampling rate can be set from 0.1 to 100 seconds.

Note: If you use Job-Mode for welding, the sampling rate defined in the selected job is used for publishing the values. Ensure that the required sampling rate is set correctly in each job upon your needs.

This sampling rate affects the update of the ACTUAL nodes on the server. Using a higher sampling rate by the OPC UA client will not deliver more updated values. Ensure that the sampling rate within the machine and/or job matches the rate of your client.

3.4 Network settings

To ensure proper function of OPC UA communication it is necessary to setup the TCP/IP parameter according to your network policy. It is recommended to use a static IP address or DHCP reservation.

Actual system data

Documentation Logbook

JOB

Job Data

Power source settings

Backup & Restore

User ma

Designation & Location

parameter display

date & time

Network settings

Management

MAC address: 00:03:AC:2D:52:EF

current IP address: 10.5.138.240

DHCP

Manual

IP address

10.5.138.240

Network mask

255.255.255.0

Standard gateway

10.5.138.254

DNS server 1

10.1.1.60

DNS server 2

Delete adjustments

Save adjustments

3.5 Time Server Settings (NTP)

For all documentation purposes within the FRONIUS welding data product family it is recommended to synchronize date and time with a local or global time server.

Actual system data

Documentation Logbook

JOB

Job Data

Power source settings

Designation & Location

parameter display

date & time

date & time

○ automatically

● manually

time zone

Europe/Vienna

date

08 / 14 / 2024

time

03 : 07 PM

Delete adjustments

Save adjustments

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4 Examples and Best Practice

This chapter includes and examples and best practice information on using OPC UA with FRONIUS welding machines.

4.1 Getting started with UaExpert Client

The easiest way to start with OPC UA on FRONIUS welding machines is to use UaExpert Client by Unified Automation GmbH. The following instruction will guide you through the first steps by using Microsoft Windows® and default settings in anonymous mode.

Step 1: Register and download UaExpert Client from <https://www.unifiedautomation.com>.

Install the software on your computer

Setup your firewall to allow TCP port 4840 for outgoing traffic.

Step 2: Connect your welding system to your network

Enable OPC UA on your FRONIUS welding system by using the SmartManager

Select encryption “none”.

Step 3: Start the UaExpert Client

Select “SERVER” and add a new connection

Double click on Add Server and enter the IP address or host name of the welding system

Open the TreeView and select discovered device and press OK.

Step 4: Select your server and connect the address space will update automatically all objects and nodes

Per drag and drop you can select the nodes you want to view or write

