

SIMATIC AX

Logic Control Engineering

Documentation

Scope

SIMATIC AX (Automation Xpansion) Logic Control Engineering is a comprehensive ecosystem for modern, collaborative, and highly automated PLC engineering. It provides a software-centric integrated development environment (IDE) and associated toolchain that bridges Information Technology (IT) and Operational Technology (OT), bringing proven software development methods — including object-oriented Structured Text (ST) and graphical Ladder Diagram (LD) programming, Git-based version control, package management, unit testing, and CI/CD pipelines — to industrial automation with SIMATIC controllers.

SIMATIC AX Logic Control Engineering is available as both a local IDE (AX Code Local) for Windows and a cloud-based browser workspace (AX Code Web IDE), enabling teams to develop, test, and deploy PLC applications from anywhere.

SIMATIC AX Logic Control Engineering supports two primary engineering workflows:

- **IT-like PLC Engineering** – Full development and deployment using SIMATIC AX tools only; no TIA Portal required
- **IT-oriented PLC Engineering with TIA Portal** – Hardware configuration via TIA Portal (V18 or later), application development and direct deployment via SIMATIC AX

Value Proposition

SIMATIC AX Logic Control Engineering transforms PLC engineering from rigid, hardware-centric workflows into agile, software-defined automation — enabling engineering teams to work as efficiently as modern software development teams.

By unifying development, testing, version control, and deployment in a single, IT-native toolchain, SIMATIC AX Logic Control Engineering reduces engineering cycle times, improves code quality through automated testing before deployment, and enables distributed teams to collaborate seamlessly on automation projects — without requiring dedicated PLC hardware for validation.

Key business outcomes:

- **Faster time-to-production** through reusable modular code, automated build pipelines, and direct cloud-based deployment — including compiler optimizations that deliver faster build times for large-scale projects
- **Reduced engineering risk** through hardware-free unit testing and automated quality gates, and structured debugging capabilities
- **Lower barriers to entry** by leveraging widely adopted IT tools and practices (VS Code, Git, CI/CD) and providing both text-based (ST) and graphical (LD) programming options to serve IT and OT engineers alike

Functionalities

Development Environment (AX Code)	- Integrated Development Environment (IDE) built on VS Code available in two variants: AX Code Local IDE: Runs on the local machine (Windows); includes Apax package manager AX Code Web IDE: Runs in the browser as a cloud-based workspace; no local installation required - CLI-first architecture: all tools accessible via command line for automation and CI/CD integration
Programming Language	Structured Text (ST): Text-based PLC programming with object-oriented programming support (methods, inheritance, interfaces, references) Ladder Diagram (LD) via XLad: Graphical drag-and-drop programming with text-based representation (YAML); interoperable calling between LD and ST - Conditional compilation via preprocessor directives for variant management in multi-variant machine projects
Package Management (Apax)	- Central package manager for dependencies, tools, extensions, and libraries via SIMATIC AX Registry - Catalog mechanism for ensuring compatible package versions across the toolchain per major release - Advanced dependency resolution with semantic versioning, dependency trees, and override capabilities - Local package support for development-phase testing without publishing to registry
Build & Compilation	ST Compiler (stc): Compiles ST source code into PLC-executable binaries with validation and optimization Hardware Compiler (hwc): Compiles text-based hardware configuration (JSON/YAML) into device-ready format; supports template generation for device parameterization
Unit Testing (AxUnit-ST)	- Automated unit testing framework for ST code - Test execution on PLC hardware or locally in the IDE without a physical PLC - Offline testing capability (no internet required) - Runtime error detection during test execution - CI/CD pipeline integration for test result reporting
Hardware Engineering	- Text-based hardware configuration in JSON and YAML - Configuration of PLC, network settings, I/O modules, and signal mapping - Configuration templates for centralized parameterization across machine variants - Structured global variables for direct symbolic signal access - PROFINET security: SNMP configuration, DCP access control, digitally signed GSDX files for integrity verification
Deployment	Hardware Loader (hwld): Transfers compiled hardware configuration to PLC

- Software Loader (sld): Deploys compiled application binaries to PLC with automatic target detection
- Remote deployment via SIMATIC AX Agent for cloud-based PLC connectivity

Debugging, Tracing & Diagnostics

- **Debugger (sdb)**: Logpoints, variable inspection, call stack capture, instance-specific debugging on running PLC
- **Monitor/Modify (mon/mod)**: Live variable observation and temporary runtime changes without redeployment
- **Tracing (trace)**: Execution flow recording for performance analysis and logic diagnosis
- **PLC diagnostics**: dashboard (PLC Online Hub), diagnostic buffer, performance information, operating mode management
- User-defined program alarms with alarm text management and process value association
- Shared connection management across multiple CLI operations for efficient commissioning

Version Control & CI/CD

- Native Git integration for source code management with code review workflows and quality gates
- CI/CD pipeline support with documented GitLab and GitHub workflow guides
- Docker Apax image creation for containerized CI environments
- Multi-project workspace support

Integration

- **TIA Portal**: AX-to-TIA library conversion (ax2tia); AX library debugging within TIA Portal
- **OPC UA**: Server interface configuration for S7-1500 PLCs; variable exposure via compiler pragmas with configurable access levels
- **Data Analytics**: Operational data acquisition, processing, and contextualization with advanced tracing support

Capabilities

Supported Programming Languages

Language	Type	Format	Standard
Structured Text (ST)	Text-based	.st files	IEC 61131-3:2013, incl. OOP
Ladder Diagram (LD) via XLad	Graphical + Text	YAML-based	IEC 61131-3:2013

CLI Tools

Tool	Command	Function
ST Compiler	stc	Compile ST to PLC binaries
AxUnit-ST	test	Execute unit tests
Hardware Compiler	hwc	Compile hardware configuration
Hardware Loader	hwld	Transfer hardware config to PLC
Software Loader	sld	Deploy application to PLC
SIMATIC Debugger	sdb	Debug on running PLC
Monitor	mon	View global variables

Modify	mod	Change variables at runtime
Tracing	trace	Record execution flow
OPC UA Server Configurator	oscr	Configure OPC UA server on PLC
AX-to-TIA	ax2tia	Convert AX libraries for TIA Portal
PLC Control	—	Centralized PLC connection management
Diagnostic Buffer	diag	Display PLC diagnostic buffer
PLC Info	plc-info	Retrieve PLC information
Performance Info	performance-info	Collect PLC performance data
Certificate Management	certificate-management	Manage PLC certificates

- Application Capacity
- Applications exceeding 16 MB supported
 - Separate 16 MB limits for VAR GLOBAL, VAR GLOBAL RETAIN, and each PROGRAM

- Compiler Performance
- Up to 50% faster compilation for S7-1500 targets with debug information enabled (Source: Release Highlights 2510, verified benchmark)

- Hardware Configuration Formats
- JSON
 - YAML

Supported Workflows	Workflow	Description	TIA Portal Required
	IT-like PLC Engineering	Full SIMATIC AX engineering including hardware configuration	No
	IT-oriented PLC Engineering with TIA Portal	TIA Portal for hardware config, SIMATIC AX for application development and deployment	Yes (V18+)

- Cloud Connectivity
- SIMATIC AX Agent for PLC-to-Cloud connectivity
 - European and Chinese data center options for Apax packages and Agent connection

- TIA Portal Compatibility
- TIA Portal V18 or later (for IT-oriented PLC Engineering with TIA Portal workflow)

- OPC UA
- Server configuration and interface management for S7-1500 PLCs
 - Variable exposure via compiler pragmas with configurable access levels

Library Ecosystem	Category	Libraries
	System	system, bitaccess, counters, datetime, edgedetection, math, selection, serde, strings, timer
	SIMATIC 1500	tasks, clocks, processimage, fileaccess
	Motion Control	motioncontrol-native (v5–8), motioncontrol (v7–8)

Testing	mocking, axunitst
Integration	ax2tia

Security

- PROFINET Security Class 1 support (SNMP configuration, DCP control, GSDX signed files)
- Certificate management for PLC communication
- Siemens ID as IDP with OIDC/OAuth with MFA Enforced
- Overall Security Documentation via <https://docs.industrial-operations-x.siemens.cloud/r/en-us/ax/industrial-cybersecurity/2510>
- Different or specialized security procedures are documented on a per component level
- All communication is done via HTTPS using TLS
- Built-in integrity check mechanism provided

User Interface

AX Code Local IDE (Windows)

- Built on Microsoft Visual Studio Code – Open Source
- Extensible via AX Code Extensions (each CLI tool has a corresponding graphical extension)
- Integrated terminal for CLI tool access
- Syntax highlighting, code completion, error checking, and refactoring for Structured Text
- Graphical Ladder Diagram editor (XLad) with drag-and-drop
- GSDML Viewer Extension for PROFINET device parameter inspection
- PLC Online Hub Extension for centralized PLC discovery, connection, and management
- Apax Extension with Workspace Explorer and Registry Explorer for graphical package management
- AXUnit-ST Extension for test management and execution

AX Code Web IDE (Browser-based)

- Cloud-based workspace accessible via web browser
- No local software installation required
- The use of AX Code Web IDE may be subject to certain restrictions depending on the workflow and components used

Command-Line Interface (CLI)

- CLI-first architecture: all tools accessible via command line
- Suitable for automation, scripting, and CI/CD pipeline integration
- Shared connection management for efficient multi-command PLC operations

Prerequisites

Platform Requirements

Platform	Requirement	Notes
AX Code Local IDE	Windows 11	Since Catalog version 2411
AX Code Web IDE	Web browser	No local installation required; supported on any browser
Alternative	Any terminal or VS Code	Via standalone Apax NPM package; Node.js 22 required
CI/CD Environment	Debian 12	CLI tools only; AX Code not supported on Linux. Debian 13 support planned
Account	SIMATIC AX Industry Organization Account	Register here
Connectivity	Internet	Required for Web IDE, cloud deployment, package management, and initial setup

Hardware Requirements

Local Development Environment:

- Standard Windows PC (Windows 11)
- For detailed hardware specifications, refer to the [SIMATIC AX Documentation Portal](#).

Device Compatibility – IT-like PLC Engineering (without TIA Portal):

Target	Details
Modular SIMATIC S7-1500	Per Hardware Engineering supported hardware list
ET200SP CPUs	1510SP-1 PN V4.0, 1512SP-1 PN V4.0, 1514SP-2 PN V4.0 (since version 2510)
PROFINET devices	All devices with GSDML files, regardless of manufacturer

Device Compatibility – IT-oriented PLC Engineering with TIA Portal (V18+):

Target	Minimum Firmware
SIMATIC S7-1500 / ET 200SP CPU / Drive Controller / S7-1500V	2.9
SINUMERIK ONE	6.23 (Library development workflow only)
SIMATIC S7-1500 Software Controller (1507S/1508S, 1505S(P)/1515SP)	30.0 (FW V40.0 since 2510.2.0)

For detailed hardware compatibility, refer to [SIMATIC AX Documentation](#).

Software Dependencies

Component	Required Version	Notes
Node.js	Version 22	Must be added to PATH during installation
.NET Desktop Runtime	8.0 (End of Support 11/26) 10.0	⚠ Both x64 and x86 versions required, even on 64-bit Windows
Microsoft Visual C++ Redistributable	Latest version	Per system architecture

Microsoft Visual Studio 2019 Build Tools	Latest	Required for unit testing and debugging (specific workloads)
Git for Windows	Latest	32-bit or 64-bit; post-install identity configuration required

Optional Software Components

Component	Purpose	When Required
SIMATIC PC Identifier	S7 communication driver for PLC connectivity	When TIA Portal is not installed
SIMATIC S7-PLCSIM Advanced V7.0	Simulated S7-1500 PLC runtime for testing	Development/testing without physical PLC
TIA Portal V18 or later	Hardware configuration for combined workflow	IT-oriented PLC Engineering with TIA Portal workflow only

Network Configuration

Parameter	Value
Required port	443 (HTTPS)
PLC connection	PG/PC Interface configuration required via Windows Control Panel
Stricter IT environments	Refer to API state endpoint for overview of all used API endpoints
Data center options	Apax packages and Agent connection routable through European or Chinese data center

Entitlements

License Type

- ☐ Backup
- ☐ Credit
- ☐ Floating / Concurrent User
- ☒ Named User
- ☐ Node-Locked / Single
- ☐ Per Asset

License Term

- ☐ Perpetual / Extended
- ☒ Subscription / Rental

Subscription Scope

Each Subscription entitles the Named User to access and use the SIMATIC AX Logic Control Engineering toolchain, including:

- **SIMATIC AX Toolchain:** ST Compiler, Hardware Compiler, Software Loader, Hardware Loader, Debugger, Monitor, Modify, Tracing, OPC UA Server Configurator, and further tools included in the SDK
- **Apax Package Manager** and SIMATIC AX Registry access (available as standalone NPM package or included with AX Code)
- **AX Code Local IDE (Windows)** – provided as recommended development environment
- **AX Code Web IDE (browser-based)** – cloud-based workspace
- **SIMATIC AX Agent** (cloud-based PLC connectivity)
- **Libraries** (System, SIMATIC 1500, Motion Control, Testing, Integration)

The Named User may use the toolchain through the provided AX Code IDE or through any compatible development environment (e.g., standard Visual Studio Code, command-line terminal).

Output Usage Rights	The Named User is entitled to deploy compiled projects (PLC applications, hardware configurations, and libraries) to an unlimited number of supported SIMATIC controllers. No separate runtime license is required.
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Other License Metrics	Usage Limitations (per subscription, per month) The following limitations apply to cloud-based services and are designed to prevent system misuse. They should not apply under normal usage conditions:
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Resource	Limit per Subscription/Month
Package Manager	116 GB
Web Workspace	135 hours
Agent Messages	4,800,000 messages

Restrictions

Unsupported Hardware Targets	The following controllers are not supported: - SIMATIC S7-1200 – not supported for any workflow - SIMATIC S7-1500 F with enabled F-activation – fail-safe functionality is not yet available for any hardware targets - Workaround: Disable F-activation to use a fail-safe PLC with SIMATIC AX tools - Exception: The SIMATIC Debugger supports PLCs with F-activation for the Library development workflow only - Redundant and high-availability CPUs (SIMATIC S7-1500 R/H) – not supported
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SINUMERIK ONE Restriction	SINUMERIK ONE is supported only for the Library development workflow (not for full PLC engineering)
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Programming Language Restrictions	Function Block Diagram (FBD), GRAPH, AWL are not available High Level Programming Languages (e.g., C/C++, Python) for PLC programming are not yet available
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Platform Restrictions	- AX Code Local IDE is not supported on Linux (only Windows 11) - AX Code Web IDE requires active internet connectivity
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Operational Restrictions	PG/PC Interface settings are not automatically configured (unlike TIA Portal); manual configuration required before PLC connection
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Delivery

Delivery Method	Siemens provides SIMATIC AX Logic Control Engineering to Customer via the SIMATIC AX Downloads page, accessible through the Customer's designated Industry Organization Account. Apax packages are sourced from the SIMATIC AX Registry, available from European or Chinese data centers. The Agent connection can be routed through either data center. Users can configure these settings as needed.
Delivery Format	- AX Code (Local IDE): Windows installer package (downloaded from SIMATIC AX Downloads page; includes Apax package manager) - AX Code (Web IDE): Cloud-based browser workspace (no local installation required) - Apax (standalone): NPM package (apax.tgz.zip) for use in any Node.js environment - enables full toolchain access from standard VS Code, command-line terminals, or CI/CD pipelines without installing AX Code - No physical media: all components delivered electronically
Installation	- AX Code: Windows setup wizard - Prerequisites (Node.js, .NET Runtime, Git, VS Build Tools, VC++ Redistributable) are not installed automatically - manual installation required per setup guide - Optional: SIMATIC PC Identifier (PLC communication driver, installed via Apax CLI) - required for PLC connectivity when TIA Portal is not installed - Optional: SIMATIC S7-PLCSIM Advanced (simulated PLC runtime) - Post-installation configuration required: Git identity, PG/PC Interface
Update Delivery / Update Process	- Catalog components: apax update --catalog - AX Code Extensions: Automatically updated - CLI tools and libraries: Updated via Apax package manager - SDK updates include bundled tools (SLD, SDB, STC, etc.) - Apax self-update: apax self-update --force-latest
Version Compatibility	- Major releases follow YYMM naming convention (e.g., 2510 = October 2025) - Patch releases follow YYMM.MINOR.PATCH scheme (e.g., 2510.2.0) - Each major release includes a Catalog (SDK) that defines compatible package versions across the entire toolchain - Refer to SIMATIC AX Logic Control Engineering Release Strategy for support lifecycle details

Technical Documentation

Online Documentation	SIMATIC AX Logic Control Engineering documentation — including reference manuals, how-to guides, tutorials, and release notes — is publicly available on the SIMATIC AX Documentation Portal .
Third Party Terms	Applicable Third-Party Terms are accessible here .

Release Notes	• Available per release on the SIMATIC AX Documentation Portal • Individual component changelogs available via SIMATIC AX Documentation Portal
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Export control regulations

AL	N
ECCN	EAR99
