B&K SERVICES & SOLUTIONS GROUP

PLC

GUIDE

Understanding PLCs HMIs and Industrial Automation Software

A practical guide to selecting and supporting Industrial control systems

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Executive Summary

Reliable automation starts with a clear understanding of what each component does. A programmable logic controller, or PLC, executes control logic and interfaces with equipment. A human-machine interface, or HMI, gives operators a way to view conditions and enter commands. Engineering software, industrial networks, and data systems connect these functions and support the equipment throughout its service life.

This white paper explains how these components work together and what to evaluate when selecting or upgrading a system. It is intended for machine builders, plant managers, engineers, and maintenance teams. The central principle is to select an architecture around the application's control, operator, data, and support requirements, then plan for maintenance and expansion from the beginning.

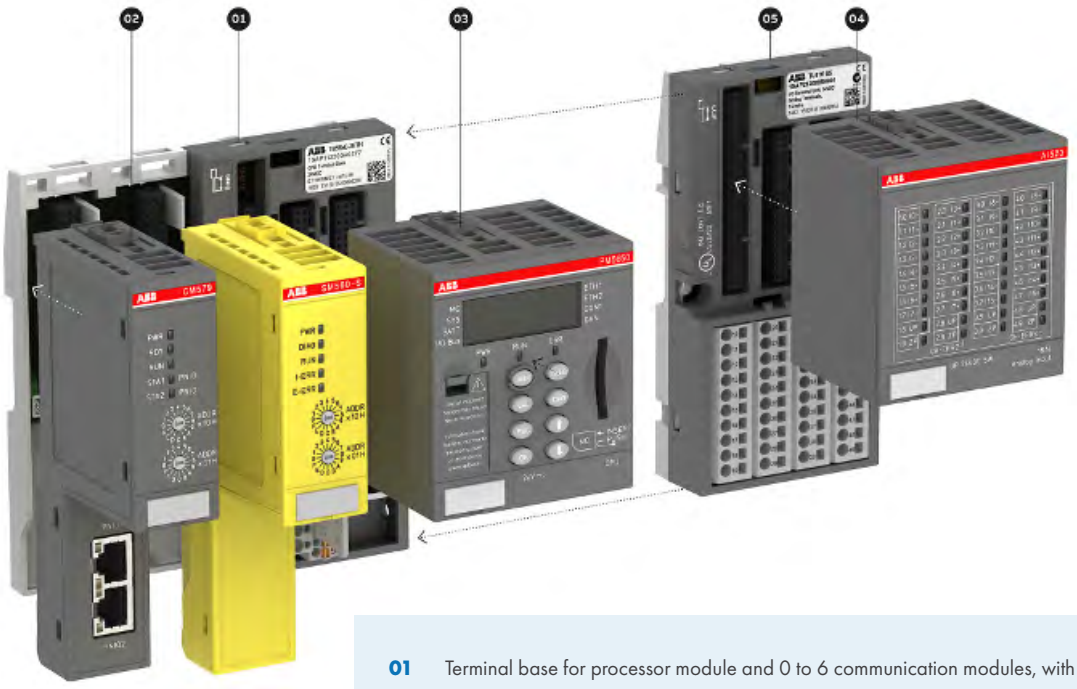
The role of the PLC

A PLC is an industrial controller designed to monitor inputs, execute a program, and update outputs. Inputs may come from pushbuttons, limit switches, pressure transmitters, temperature sensors, encoders, and networked devices. Outputs can command motor starters, valves, relays, drives, and other equipment.

A typical cyclic program reads input information, evaluates control logic, and updates outputs repeatedly. Scan time depends on the controller, program complexity, communication load, and task configuration. Some systems also use timed or event-driven tasks. The required response time should therefore be established from the application rather than assumed to be the same for every PLC.

For example, a PLC can coordinate a conveyor sequence, regulate a pump through a VFD, or manage valve operation in a process skid. Its program evaluates commands alongside permissives, interlocks, and feedback. PLCs provide flexibility compared with relay-only designs, but changes still require engineering review, testing, and updated documentation.

Standard control logic should not be assumed to perform a safety function. Where the application requires safety-related control, the design must use suitable safety-rated devices and validated functions based on the system risk assessment.



01 Terminal base for processor module and 0 to 6 communication modules, with serial and Ethernet interfaces

02 Communication module for, e.g., PROFIBUS, PROFINET, CAN,EtherCAT, and for support of safety solution

03 Processor module with integrated communication

04 I/O module, up to 10 I/O modules can be connected

05 Terminal unit for I/O modules, also for decentralized extension

The role of the HMI

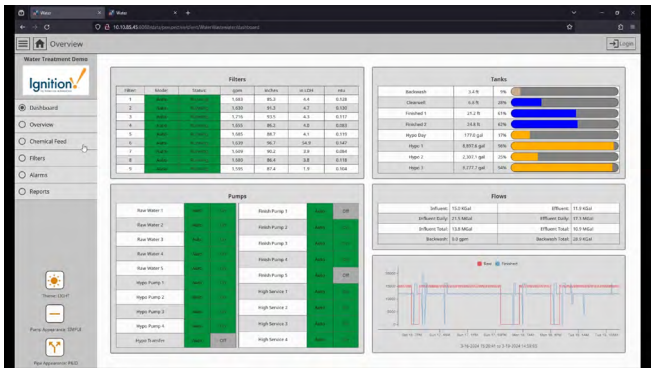
An HMI is the operator's visual interface to a machine or process. It communicates with a PLC or other devices to show equipment status, process values, alarms, trends, and maintenance information. Depending on the platform, it can also support recipes, production counts, multiple languages, and user access controls.

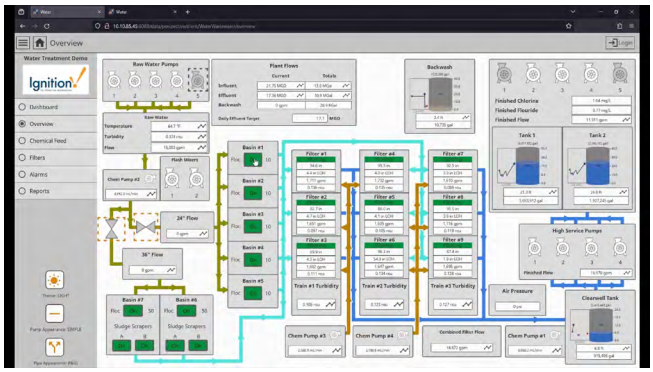
Operators may use an HMI to request a start, stop, or setpoint change. The PLC evaluates that request through its control logic. A screen command should not bypass required permissives or interlocks. Combined PLC and HMI products place these functions in one device, but the distinction between control and visualization remains useful when designing and maintaining the system.

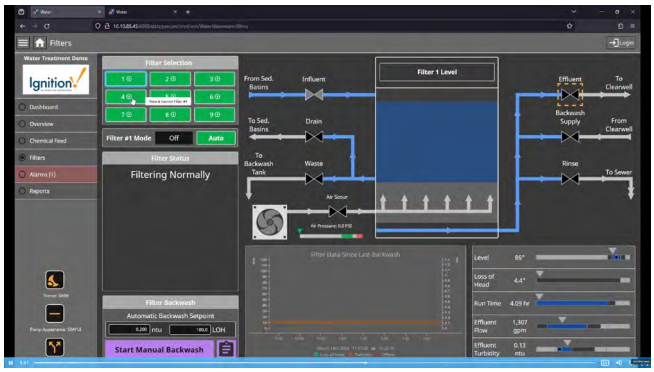
An effective interface makes important conditions easy to understand. Consistent terminology, clear equipment status, useful alarm messages, and access appropriate to each role can help operators respond more confidently. The interface is only as useful as the underlying data and the way it is presented.



integrated PLC/HMI







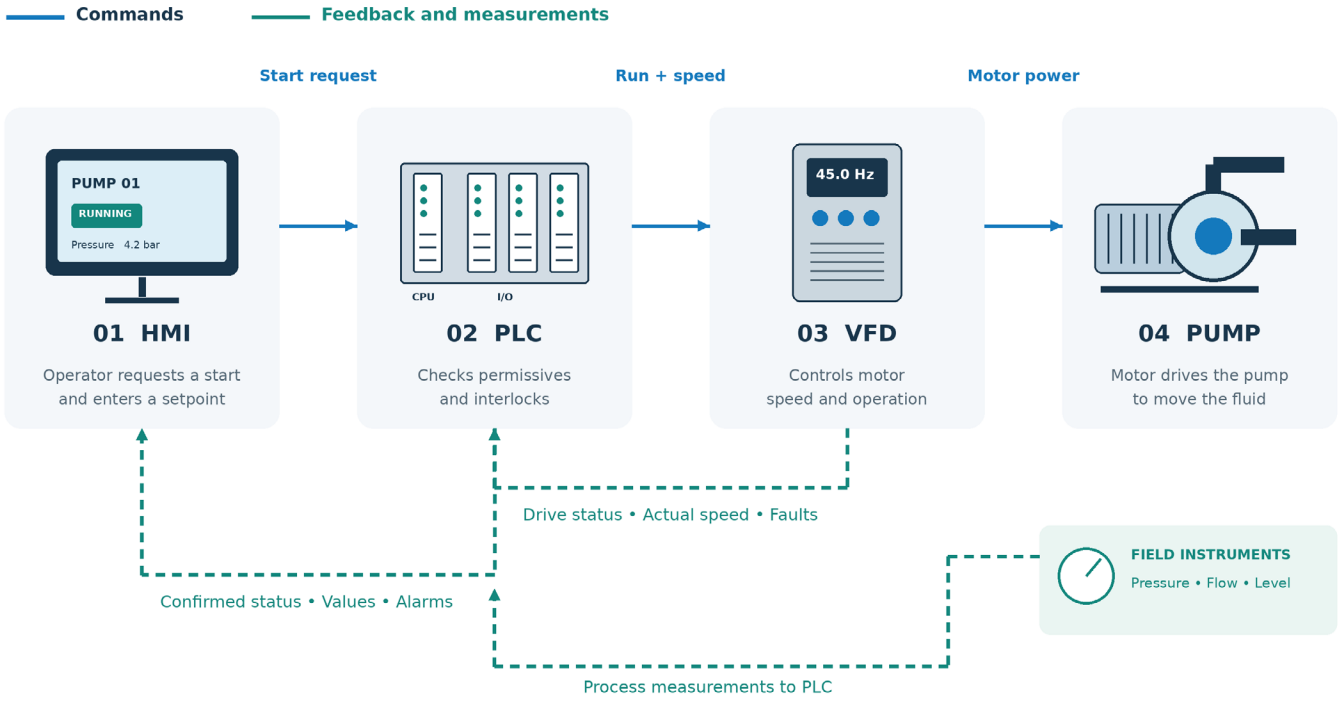
How control and visualization work together

Consider a pump controlled by a PLC and VFD. An operator enters a start request on the HMI. The PLC checks the required operating conditions and, when they are satisfied, issues a command to the drive. Feedback from the drive and field instruments allows the PLC to determine actual operating status. The HMI then displays that feedback.

This distinction prevents a common design problem: displaying a command as though it confirms equipment operation. A requested start and a confirmed running condition are different pieces of information. Showing both, where appropriate, helps personnel distinguish a control request from a device or process problem.

How a pump control system works

From operator request to confirmed operating status.



A start request is not proof that the pump is running. Display confirmed feedback.

When SCADA adds value

Supervisory control and data acquisition, or SCADA, provides a broader layer of monitoring, data collection, and supervisory commands. It commonly connects multiple controllers or remote terminal units across a facility or geographically distributed operation. Local control remains with the field controllers while the supervisory system presents a consolidated view.

A standalone machine can use a PLC and HMI without needing a SCADA platform. A water utility, treatment plant, or larger manufacturing operation may need centralized alarms, historical trends, reporting, and visibility across multiple systems. SCADA installations may include servers, operator clients, communication infrastructure, and a historian that stores time-based operating data.

The need for SCADA should follow the operating requirements. Connecting machines to a network alone does not define a complete supervisory system; the information, operator workflows, availability requirements, and responsibilities must also be designed.

Engineering and visualization software

PLC engineering software supports program development, hardware and I/O configuration, communication setup, commissioning, and diagnostics. Common programming approaches include Ladder Diagram, Function Block Diagram, Structured Text, and Sequential Function Chart. Available languages and functions vary by controller and development environment.

HMI software is used to build screens, map data tags, configure alarms and trends, define recipes, and establish user permissions. Some manufacturers combine PLC and HMI development in one environment; others use separate tools. SCADA software typically adds supervisory functions, broader data handling, and client or server configuration.

Evaluate the software as carefully as the hardware. Licensing, version compatibility, engineering access, staff familiarity, and the ability to recover a project all affect long-term support. Keep editable source projects and required dependencies, rather than relying only on the files running in the device.

Choosing a system architecture

A basic machine architecture may use one PLC, local I/O, and an HMI. Distributed I/O can place connections closer to field devices, supporting larger machines and reducing some wiring runs. A supervisory architecture can connect multiple control systems for facility-wide monitoring. Industrial PCs can support visualization, vision processing, reporting, analytics, or control, depending on the platform.

These options can be combined. A facility may use local machine controllers, distributed I/O, and SCADA, with industrial PCs handling additional software tasks. Start with the required functions and response times, then determine how the components will communicate and how each part will behave if a connection or device fails.

Combined PLC and HMI products can save panel space and simplify some standalone applications. Evaluate I/O capacity, processing needs, interface requirements, repair options, and the operational effect of losing both functions in a single device. A lower initial purchase price does not always produce a lower lifetime cost.



Industrial communication

Communication choices must match the devices and the application. Common industrial Ethernet technologies include EtherNet/IP, PROFINET, Modbus TCP, and EtherCAT. OPC UA supports structured information exchange between compatible systems and applications. They serve different purposes and are not automatically interchangeable.

Serial systems remain common in legacy equipment and some field applications. Modbus RTU is a communication protocol; RS-232 and RS-485 describe electrical interfaces. Confirm device support, wiring requirements, addressing, and communication settings before specifying a connection.

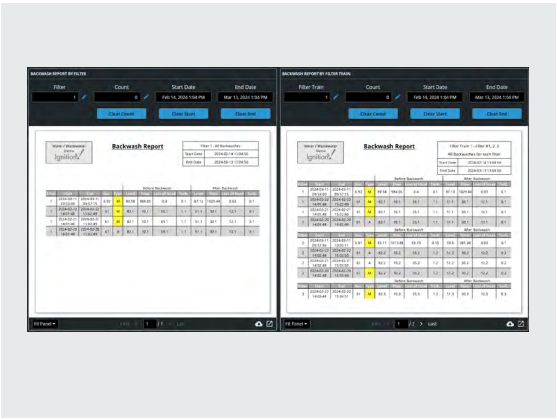
MQTT and web APIs may support communication with reporting platforms or other enterprise systems. Such connections should be designed around the information needed, its update rate, and the security requirements. Cloud reporting does not replace the local controller's responsibility for time-sensitive machine operation.

Ethernet connectivity does not automatically provide encrypted or authenticated communication. Security depends on the protocol, device capabilities, configuration, and network design. OPC UA provides security mechanisms such as authentication, signing, and encryption, but those mechanisms must be selected and managed appropriately.

Making operational data useful

Automation systems can collect cycle times, part counts, runtime hours, process values, alarm events, and downtime information. Define how each value will be used before building the data collection system. Useful reporting depends on consistent units, timestamps, equipment names, and agreed definitions of operating states.

For example, a downtime report needs a clear distinction between a planned stop, a process interruption, and an equipment fault. Historical trends become more useful when they can be compared with alarm records and maintenance activity. Data retention, sampling rates, and storage capacity should reflect the decisions the information must support.



Alarm design deserves the same attention. Messages should describe the abnormal condition and help personnel understand an appropriate response. Priorities should reflect the consequence and required response time. Alarm acknowledgment records an operator action; it does not necessarily clear the condition or demonstrate that it has been corrected.

Diagnostics such as communication errors, drive fault history, I/O status, and controller health help maintenance teams investigate problems. Historical information can support root-cause analysis and preventive maintenance, but the accuracy and context of the data must be checked before drawing conclusions.

Access control and cybersecurity

Assign permissions according to job responsibilities. Operators may need routine commands, supervisors may need approved setpoint changes, and engineers may need programming access. Use individual accounts where supported, protect credentials, and remove access that is no longer required. Shared default passwords undermine accountability.

User permissions are one part of operational technology security. Network segmentation, controlled remote access, secure configuration, asset inventories, monitoring, and a planned approach to patching also matter. Coordinate these measures across engineering, operations, and IT so that security changes account for equipment availability and process requirements.

A firewall alone is not a complete security program. Protect backups, review access periodically, and establish a recovery plan for failed or compromised systems. Evaluate remote and mobile visualization against the same access and network requirements as other connections.

Questions to answer before selecting a platform

- Q **Control requirements:** How many digital and analog I/O points are needed? What response times, motion functions, memory, redundancy, or safety functions does the application require?
- Q **Operator requirements:** What screen size, viewing conditions, environmental rating, alarm functions, recipes, languages, and permissions are needed?
- Q **Integration requirements:** Which drives, instruments, robots, and other controllers must connect? Are the required protocols and data interfaces supported by each device?
- Q **Data requirements:** What information must be logged, who will use it, and how long must it be retained? Are reporting or regulatory records required?
- Q **Support requirements:** Who will program, commission, and maintain the system? Are software licenses, spare parts, documentation, and local technical support available?
- Q **Lifecycle requirements:** What future expansion is expected, and what is the plan for product obsolescence, software updates, and migration?
- Q Compare total cost of ownership, including engineering, installation, training, licenses, support, spares, and future upgrades. The right platform meets the application's requirements while remaining practical for the people responsible for it.

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Maintenance and lifecycle planning

Maintain controlled backups of PLC programs, HMI and SCADA projects, drive settings, network configurations, and related software dependencies. Keep electrical drawings, I/O lists, network diagrams, version records, and change history current. Verify that backups can be restored using available tools and licenses.

Review alarm history, communication performance, hardware condition, and security settings as part of planned maintenance. Where possible, investigate recurring faults before they become larger interruptions. Make changes through a documented process that includes review, testing, and a recovery path.

Plan modernization before essential products become unsupported. A phased approach can help manage cost and disruption, but the migration plan must address compatibility, testing, commissioning, and continued operation during the transition.

Preparing for future capabilities

Edge computing, connected reporting, browser-based visualization, and analytics can extend the value of an automation system. Processing information near the equipment may reduce the data sent to central systems and support faster analysis. Cloud services may provide additional reporting or asset management capabilities when connectivity and security requirements are addressed.

AI-based tools can also help analyze operating data, but results depend on data quality and must be validated against the application. Start with a defined business problem, such as recurring downtime or inconsistent quality, and establish how improvement will be measured. New capabilities should support a reliable control foundation.

Working with B&K

Understanding the roles of PLCs, HMIs, software, and networks makes it easier to select an appropriate system and support it throughout its life. Begin with the process requirements, design clear operator interactions, and plan for maintenance, security, and expansion together.

B&K Electric Wholesale can help you discuss your control system requirements and evaluate the next steps for an automation project.

Contact our team at powertosolve@bk-electric.com or (800) 422-2635