White Paper

Today's most critical criteria for choosing the best basic PLC Solution to modernize today's industrial enterprises

Consumer demands put growing pressures on industrial operators to respond with mass customization, ever higher throughputs and 24/7 runtimes to maximize asset utilization. Production at scale requires PLCs for automation and control, but not all are created equal. Many lack the features and capabilities to meet the flexibility, reliability and security demands of Industry 4.0 enterprises. That's why OEMs and end-users intent on modernizing their equipment and factories should consider the six core criteria explained in this paper when choosing the right PLC for their upgrades.

The next-generation of industrial digitalization - a combination of Industry 4.0 concepts enabled by IoT (IoT) connectivity - can support a profound transformation across just about every industry around the world. It provides for the gathering and analyzing of data across machines, even entire fleets of machines across different plants, in ways that were not possible with older automation and control technology. In turn, these data-driven capabilities can offer greater operating visibility, flexibility, and efficiency, so manufacturers can produce higher-quality goods at less cost and in less time.

While many plant operators may understandably hesitate to replace or upgrade currently working and fully depreciated operational technology (OT) production infrastructure, the opportunity costs of the status quo grow bigger each day.

That's because advanced automation and control technology offers higher throughput rates, simplified and more visible operations, reduced maintenance and repair costs, and accelerated times to market. In short, to stand still is to fall behind industry performance benchmarks and the competition.

What's more, today's more digitalized automation and control technology is quickly emerging as the answer to the "grey tsunami" of retirements that is now emptying the ranks of older highly skilled industrial engineers and technicians, taking with them the expertise and experience in operating legacy industrial technology installed years if not decades ago.

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For OEMs and plant operators considering the modernization of their production infrastructures, it's best to start with choosing the best available replacement for the core device behind their automation and control: the PLC. But not all PLCs are equal in their features and capabilities. Many available today are in the late stages of decades-long product lifecycles and fall short of what's needed to fully modernize production.

In cases where OEMs and plant operators are looking to replace end-of-life PLCs and upgrade to today's more advanced PLC capabilities, this white paper provides six key criteria as guidance to help them evaluate their PLC upgrade options and choose a PLC that will provide the modernization capabilities and benefits they seek, while providing reliable service for many years to come.

Compact design and a modular, open architecture

For most plant operations, production modernization can be achieved with a basic PLC, such as the Siemens SIMATIC S7-1200 series with its compact design and modular, open architecture. It also uses a common software engineering framework, the TIA Portal, which differentiates it from late-stage basic PLCs and cheap commodity PLCs.

But "basic" today means a lot more than what it did years ago: More features. More capabilities. More benefits. A new, next-generation PLC should enable OEMs and plant operators to meet their needs now and easily scale to meet growth and flexibility in production demands of tomorrow. It should offer a wide range of configurations and allow additional functional components to be simply added without impacting current operations or causing significant production downtime.

That's why, when planning production upgrades, OEMs and operators should consider basic PLCs that are compact and modular, with plug-and-play interoperability across multiple devices. Plus, the PLC selected should have the flexibility to expand using plug-in signal modules that can simplify wiring and servicing tasks. Examples of such application-specific functions include:

- Condition Monitoring/Predictive Maintenance
- Weighing
- Dosing/Filling
- Belt Scales
- Load Cells
- Energy Metering

Integrated safety and security

Beside being optimized for cost-effectiveness and high throughput rates, modernized production lines must also comply with the strict safety requirements required in industrial environments. When safety is not integrated into PLC software and hardware – as is the case in most older automation systems – compliance becomes significantly more challenging to maintain, upgrade, and scale.

Conversely, today's basic PLCs should have built-in safety and security integration, configurable directly from within a common engineering framework. This integration will simplify engineering and deployment, while enabling easy scaling and flexibility. By using local or fieldbus systems, operators can easily expand safety functions while allowing flexible configurations that don't compromise the integrity of the safety or control system.

Safer working environments. When safety is integrated into a basic controller, as it is in the SIMATIC S7-1200 series, it also means fewer parts – plus installation, wiring, and all associated costs – are needed, thus reducing the total cost of ownership. Integrated safety functions improve overall diagnostics and troubleshooting, providing less downtime for maintenance and repair. Of course, less downtime for safety systems can increase machine availability, overall plant productivity, and, most importantly, provide plant personnel with a safer working environment.

Safety-integrated PLCs, such as the SIMATIC S7-1200 series, are able to handle the strictest safety requirements for applications according to IEC 61508 up to SIL 3 and ISO 13849-1 up to PL e without the need for external safety processors or relays.

Multilayered security. Older PLCs were never designed to take advantage of today's hyper-connectivity across IT and OT internal networks nor to defend against the external online threats from hackers, viruses and other malware.

The costs and safety hazards from compromised networks could be immeasurable, given that life safety within the plant and even the surrounding community could be at stake. To protect against unauthorized access to networks and minimize vulnerabilities, security must extend across a plant's entire production network while keeping in mind and accommodating OT's deterministic, real-time requirements.

For multilayered security that ensures the network is protected from the control level up to MES and ERP systems, a common engineering framework can save a lot of time. Rather than configuring firewalls, encryption, VPNs and role-specific authentication separately, plant engineers can administer security access from a single interface with relatively little effort.

> "While each safety switching device has a specific function, the parameters can change frequently. That's something that wouldn't be feasible with a conventional hard-wired safety system. And installation is also much more economical, as it reduces the time and labor required by 25 percent."
>
> – Dean Colwell, Controls Engineering Manager for Assembly and Welding Systems, Fori Automation

Access control. Access control at the controller level safeguards against unauthorized users by tying user permissions to specific, privileged passwords, so users are only able to access certain online or offline functions of the CPU according to their unique access rights. Multifactor authentication can also be enabled to build-in additional levels of protection and user accountability.

User Management Access Control within the common engineering framework also protects CPU logic against unauthorized reading, editing or copying of "know-how" protected blocks.

To protect intellectual property and development investments against the unauthorized duplication or reverse-engineering of PLC programs, projects and blocks can also be copy-protected by binding the program to serial numbers of the running CPU or optional memory card. Secure certificate-based OPC UA communications through encryption, signing, and authentication protects against unauthorized manipulation to guard against intrusions and ensure high availability of control systems.

Efficient engineering and integrated technology

Controllers that are programmed on a common software engineering framework, such as the SIMATIC S7-1200 on the TIA Portal, can employ the working principles of continuous integration to enable faster programming and greater cross-functional collaboration across the entire organization. Standardization and modularization speeds up engineering and reduces time to market with an integrated code library concept. This makes common functions, components and subcomponents easily replicable across the entire automation system. Maintenance and version control management are simplified, as well.

Configuration control. Option handling, also known as configuration control, allows for the same controller to be programmed to satisfy varying requirements on the shop floor without changing hardware configurations or user programs.

This flexibility enables engineers to configure entire plants using modular function groups. These allow individual machine groups to be adjusted at any time via simple configuration activation, without major changes to production engineering or causing operational disruptions.

And because the configuration activation happens at both the plant and machine levels, a new topology can be created automatically. This way, engineers can define all options in a single engineering project with the ability to update and execute changes, greatly reducing their engineering time and efforts.

More technology, more capabilities. A single common software engineering framework that allows for third-party and other external hardware to be integrated into control automation can also be used to set up a virtual commissioning environment for operational changes.

By performing process and control changes virtually, engineers are able to significantly reduce time-to-market and eliminate possible damage to equipment or personnel by ensuring all hardware and software – PLC, HMI, VFD, I/O, networking, safety, and security – are tested together.

Today, basic PLCs are available that are built with more sophisticated CPUs to support closed-loop positioning feedback, such as High Speed Counting (HSC) inputs, pulse train outputs, and motion control for greater availability and more intelligently designed production processes.

> "The hardware, including basic and advanced safety controllers, was as much as 40 percent less expensive than our other supplier and software."
>
> – Bill Taylor, BWI Group Controls Engineering Manager

Integrated diagnostics and maintenance

Reduced downtime with real-time reporting. The newest generation of basic controllers come with advanced, real-time diagnostics and reporting for quick fault analysis. Simple, plain-text system messages clearly communicate system diagnostics without complex programming or configurations and are displayed across multiple media, such as HMI displays, integrated web servers and within the common engineering framework.

The integrated web server enables online diagnostics and access-from-anywhere reporting capabilities, plus integrated signal traces allow for quick and easy localization of sporadic faults. Faster, more efficient troubleshooting cuts down on commissioning time and minimizes production downtime to keep throughput rates and plant performance high. In fact, the integrated diagnostics of the SIMATIC S7-1200 PLC can support the virtual commissioning of automation and control systems using 3D digital twins of the machines and production cells or entire production lines, thereby reducing overall time to market for new products by weeks if not months. Virtual commissioning can also be used for operator training before physical commissioning occurs, also saving time.

Industrial IoT connectivity

The industrial Internet of Things IIoT) promises to bring greater visibility and control to manufacturing processes. To achieve this potential, industrial data networks need interconnected solutions able to support increased connectivity requirements despite the harsh conditions often found in manufacturing facilities. Controllers that allow integration with third-party systems and machine-to-machine communications enable OEMs and end users to build a comprehensive infrastructure of multiple gateways and IT/OT networks, open user communications, security protocols as well as communication drivers that make it easy to connect assets to cloud infrastructure.

IoT-enabled controllers have the following open user communication capabilities:

- TCP/IP, UDP, HTTPS, TLS/SSL
- Fieldbus protocols (Profinet, Modbus TCP or RTU, AS-I, IO-Link, BACnet, USS/RS-232/RS-485, CAN)
- OPC UA
- Multiple gateways (CAN, BACnet, J1939)
- IT/OT network integration (ethernet TCP/IP, OPC UA)
- MQTT

Some controllers can even function as "edge" devices or gateways, making it possible to combine the advantages of a cloud with the real-time availability of a local solution, allowing various data to be collected and optimized in local, cloud-based and hybrid applications.

Machine-as-a-service (MaaS). IoT-connected PLCs offer OEMs the possibility of offering their customers flexible, pay-as-you-go/grow MaaS subscription models that can conserve capital. Recently, the MaaS concept has emerged as a means to fulfill multiple business requirements beyond traditional machine operations with tightly bound speeds and feeds.

MaaS models take advantage of IoT connectivity to adopt a more agile approach to upgrades and rollouts of new features and capabilities. For example, regular software upgrades can enhance or expand the capabilities of an existing IoT-connected machine without disrupting operations. This can help extend the machine's lifespan, while delivering greater operational flexibility and further integrating the machine into a business-wide ecosystem that includes performance optimization analytics and reporting.

IoT connectivity also enables the PLC to offer predictive maintenance and condition monitoring capabilities to operators at the field, control, supervisory and enterprise levels. For example, a characteristic-based and frequency-selective analysis can diagnose and predict machine failure, allowing operators to schedule downtime based on production schedules, thus reducing maintenance costs and unplanned downtime.

Machine-as-a-Service (MaaS)

IoT connectivity enables OEMs to monitor machine performance for faults ond failures while condition monitoring software offers calculated insights into predictive maintenance analysis. Further, it allows plant operators to take advantage of the MaaS consumption pricing model, so they only pay for the machine's production output, based on agreed upon KPIs – also known as "pay as you go." This shifts upfront capital expenses to operating expenses.

Since maximum uptime means maximum throughput – ultimately the revenue for both parties in a MaaS-machine contract – OEMs are incentivized to keep the machines in top shape thereby enacting a robust preventative maintenance strategy to ensure performance levels remain high.

Responsive global support

When adopting any new technology, such as a new PLC, the availability of responsive global support is critical to the efficient engineering, deployment, commissioning, operation, and service of the PLC as well as its interconnected devices and machines. Such is the case with the SIMATIC S7-1200 series of PLCs.

Partnering with a company like Siemens that has a long-standing history in automation and manufacturing will ensure all operational requirements are understood and accounted for. It's important to consider the financial strength and portfolio diversity of the company to ensure it will be able to provide support for decades to come.

Rather than investing in promising up-and-coming companies with a limited track record of integration or interoperability, OEMs and plant operators should look for partners, such as Siemens, that are investing significant resources and money into legacy machine integration with Industry 4.0-inspired technologies.

This way, they can be sure emerging trends and innovations are compatible with older machines and support offerings, protecting their legacy investments while opening a viable path to future upgrades and capabilities.

To stay competitive, OEMs and plant operators need a basic controller that keeps pace with the increase in customer requirements, functional complexity, and time-to-market demands.

Today's manufacturing transformation is being driven by consumer-centric market forces and powerful technologies that are also defining the new landscape of globalization that manufacturers must compete in.

To support the highly connected global manufacturing supply chains that feed consumer demands, OEMs and plant operators should give serious consideration to the new generation of PLCs and automation to keep pace with the increase in customer requirements, functional complexity, and time-to-market demands that have emerged as a result.

The good news is that upgrading automation and control systems can be done with little to no production disruptions, and many plant operators will find these upgrades pay for themselves within a very short time.

including LAD (Ladder Diagram), FBD (Function Block

Siemens SIMATIC S7-1200 PLC

Designed for digital modernizations of legacy OT production infrastructure, the Siemens SIMATIC S7-1200 series of PLCs provide a cost-effective solution for basic automation tasks and includes the following:

- Engineering using the Siemens Totally Integrated Automation Portal (TIA Portal) which provides a common framework for open and multi-user engineering of control logic, plus fully integrated safety and security functions.
- Standard support for IEC 61131-3 programming languages including LAD (Ladder Diagram), FBD (Function Block Diagram), SCL (structured text).
- Real-time diagnostics available via TIA Portal, HMI display, integrated web server plus external tools such as SIMATIC Automation Tool, Proneta, and others.
- Integrated PID control allows for simple configuration, commissioning and tuning closed-loop PID controllers.
- User Management Access Control (UMAC) in the TIA Portal can prevent unauthorized users from accessing or modifying the offline copy of TIA Portal Projects.
- Open Platform provides maximum flexibility for cloud and multi-user engineering.
- Motion control functionality via PROFIDRIVE and/or Pulse Output (PTO/PWM).
- Cloud connectivity to Siemens MindSphere or other third-party cloud platforms with common cloud protocols, such as MQTT and OPC UA.
- Predictive maintenance with integrated condition monitoring capabilities ensures maximum machine availability with minimal unplanned downtime.
- Edge integration via PROFINET and TM MFP enables local and cloud-based analysis.
- Siemens responsive global support and continuing R&D in adding functionality and capability.

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