WOODWARD

Application Note 83408
Original Instructions

PLCs for
Turbine Control Systems

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Introduction

Programmable Logic Controllers (PLCs) are currently being utilized for full turbine control by some control suppliers and some turbine OEMs and are being considered by some turbine system packagers. PLCs are available from at least a half-dozen suppliers, including GE Fanuc and Allen Bradley. Each of these suppliers has its own mix of modules and its own system for product distribution. Their target design market is not turbine control, but the myriad of everyday bread-and-butter control applications of general industry and automation.

In general, only standard I/O is available from the PLC vendor. Full turbine control requires some special modules, such as speed sensors, fast protection thermocouples, LVDTs, servo actuator drivers, vibration interfaces, and special serial interfaces. Some of these modules are available from specialty suppliers (not the PLC vendors), or they can be manufactured by or for the control packagers to their own design specifications.

Utilizing the PLCs in any control scenario involves both selecting the appropriate PLC hardware—including that PLC vendor's programming environment—and then programming the system. In other words, both hardware and software issues must be addressed.

The general appeal of PLCs would seem to be composed of one or more of the following considerations:

- Low purchase cost, due to standardization
- Purchaser's **command of the control system design**, due to hardware modularity and perceived programming flexibility
- "Local" **support** for the system, due to wide availability of at least the larger PLC suppliers' hardware and the increasing availability of third-party special modules

We'll take a closer look into both the hardware and software aspects later in this paper.

Some General Observations

Third-party suppliers play a key role in the product line-up of many PLCs. Fanuc manufactures only four I/O modules (4–20 in, 4–20 out, discrete in, discrete out). Third-party suppliers (such as Horner, KEP, SYCOM, Delta Tau) provide at least 30% of turbine control I/O modules. Some specialty modules must be purchased directly from the controls' supplier because they are not available through PLC distribution.

PLC chips have specific I/O limits. For large and/or complex applications, a single processor is not sufficient and additional processing units are required.

Most of the ordinary programming needs for PLCs are accomplished within the ladder logic environment. Certain analog-type functions are also provided within this framework. For the additional functionality required in a turbine control system, either Basic or C language programming is necessary.

The key software requirement for a turbine control system involves the utilization of rate groups in order to achieve the critical timing of functions required for PIDs, ramps, etc. The software responsible for such timing is generally buried deep within the software structure of the PLC itself. For a turbine control system, the user/programmer must access this core software, and modify the programmable interrupts within the PLC code to set up this rate group structure. These modifications will be written in Basic or C language. Generally, changes to the size of the application will cause timing changes in the PLC and the rate group software.

Because of design and module-capability differences among the many PLC manufacturers, it is usually not practical for a PLC packager to be familiar with or support more than a single vendor. This could lead to problems in supplying users who may be standardized on a different PLC vendor.

System Costs

The cost of basic hardware and I/O for a PLC is relatively low. However, a full turbine control PLC requires:

- Additional third-party hardware, at a price and availability well beyond the basic hardware.
- Custom software development for the rate group timing and non-linear algorithms. This is either purchased outside or requires a large investment for extensive in-house programming capability, plus the cost of maintaining this capability for the life of the control system.
- Provision for several co-processors, according to the size of the project.
- Very large amounts of systems and turbine control expertise to convert the hardware and software into an ongoing workable control system that will serve for many years.
- Factory testing capabilities.

Based on several comparisons from many available bid documents and purchase orders, the overwhelming evidence indicates that by the time a complete control system is fully designed, the apparent cost advantage of the PLC has disappeared.

Control System Design

Special I/O needs or co-processor requirements will require the control system designer to utilize third-party designers and/or suppliers, thus giving up that measure of the desired in-house control.

Establishing and maintaining the specialized programming capability in-house requires major engineering resources. This is further complicated by the irregular demand for these specialists—what do they do while waiting for their services to be required? This is not so bad for repetitive applications of the same program. But, if/when the next unit(s) is (are) different, if parameters such as the fuel or acceleration schedules need to be changed, or if there are special communication requirements, a considerable amount of highly professional programming is needed.

Most importantly, the special programming, in Basic or C, whether done in-house or purchased outside, is very particular to individual code writers. Unavailability of those particular individuals, for so many possible reasons, would cause any changes to that code to be very difficult or impossible. It could be necessary to start all over again.

Local Support

The local PLC supplier is an industrial distributor, with little influence with the PLC manufacturer. Any expertise this distributor has is in the area of general applications, not turbine control. This distributor cannot help in sorting out any turbine control system problems.

The more critical modules are provided in-house or, more usually, by third parties. Sometimes these third-party suppliers are small companies and are almost always single-sourced. The availability of local support can be dependent on that supplier's field service facilities and policies.

A large degree of site individuality is usually required for turbine controls. Turbine OEMs offering "standard" PLC packages are necessarily limited in the amount of customizing they can provide to meet the user's individual application needs. Users who accept "canned" solutions should evaluate the short-term cost consideration versus the long-term advantage of having a control system that is or can be tailored to their present and future needs. Support with such a large degree of flexibility, especially considering the software requirements, is difficult or impractical with many PLC-based control systems.

Next-generation software tools from PLC vendors don't generally work on systems with customized codes. Upgrades and future revisions to the PLC system will require more changes to the modified software, if the advantages of those new tools are to be realized.

Basic and C codes are difficult to maintain across a significant number of employees. Changes are more readily accomplished by the original author of the code. Again, should that author be unavailable, problems and complications are more probable.

The dependence on software experts can be eliminated with a strong high-level reprogramming tool (such as the Woodward Graphical Applications Programmer). With such, any turbine engineer or technician (not a programming specialist) can accomplish changes quickly and in a straightforward fashion – and for the life of the control.

Software—and the support of it—is really the key issue!

Key Considerations

Potential users of PLC hardware and software for full-turbine controls ultimately will need to address all of the following issues:

- Changing control strategies that require custom software
- Special third-party I/O modules
- Long-term support
- Costs of maintaining a programming staff that is amortized over a relatively low number of units

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2010/3/Fort Collins