10. SELECTING A PLC

Topics:

- The PLC selection process
- Estimating program memory and time requirements
- Selecting hardware

Objectives:

- Be able to select a hardware and software vendor.
- Be able to size a PLC to an application
- Be able to select needed hardware and software.

10.1 INTRODUCTION

After the planning phase of the design, the equipment can be ordered. This decision is usually based upon the required inputs, outputs and functions of the controller. The first decision is the type of controller; rack, mini, micro, or software based. This decision will depend upon the basic criteria listed below.

- Number of logical inputs and outputs.
- Memory - Often 1K and up. Need is dictated by size of ladder logic program. A ladder element will take only a few bytes, and will be specified in manufacturers documentation.
- Number of special I/O modules - When doing some exotic applications, a large number of special add-on cards may be required.
- Scan Time - Big programs or faster processes will require shorter scan times. And, the shorter the scan time, the higher the cost. Typical values for this are 1 microsecond per simple ladder instruction
- Communications - Serial and networked connections allow the PLC to be programmed and talk to other PLCs. The needs are determined by the application.
- Software - Availability of programming software and other tools determines the programming and debugging ease.

The process of selecting a PLC can be broken into the steps listed below.

1. Understand the process to be controlled (Note: This is done using the design sheets in the previous chapter).
    - List the number and types of inputs and outputs.
    - Determine how the process is to be controlled.
    - Determine special needs such as distance between parts of the process.
2. If not already specified, a single vendor should be selected. Factors that might be considered are, (Note: Vendor research may be needed here.)
    - Manuals and documentation
    - Support while developing programs
    - The range of products available

- Support while troubleshooting
- Shipping times for emergency replacements
- Training
- The track record for the company
- Business practices (billing, upgrades/obsolete products, etc.)

3. Plan the ladder logic for the controls. (Note: Use the standard design sheets.)
4. Count the program instructions and enter the values into the sheets in Figure 102 and Figure 103. Use the instruction times and memory requirements for each instruction to determine if the PLC has sufficient memory, and if the response time will be adequate for the process. Samples of scan times and memory are given in Figure 104 and Figure 105.

PLC MEMORY TIME ESTIMATES - Part A

Project ID: _____

Name: _____

Date: _____

Instruction Type	Time Max (us)	Time Min. (us)	Instruction Memory (words)	Instruction Data (words)	Instruction Count (number)	Total Memory (words)	Min. Time (us)	Max. Time (us)
contacts								
outputs								
timers								
counter								
					Total			

Figure 102 Memory and Time Tally Sheet

PLC MEMORY TIME REQUIREMENTS - Part B

Project ID: _____

Name: _____

Date: _____

TIME

Input Scan Time	_____us	
Output Scan Time	_____us	
Overhead Time	_____us	
Program Scan Time	_____us	
Communication Time	_____us	
Other Times	_____us	
TOTAL		_____us

MEMORY

Total Memory	_____words	
Other Memory	_____words	
TOTAL	_____words	_____bytes

Figure 103 Memory and Timer Requirement Sheet

Typical values for an Allen-Bradley micrologix controller are,
input scan time 8us
output scan times 8us
housekeeping 180us
overhead memory for controller 280 words

Instruction Type	Time Max (us)	Time Min. (us)	Instruction Memory (words)	Instruction Data (words)
CTD - count down	27.22	32.19	1	3
CTU- count up	26.67	29.84	1	3
XIC - normally open contact	1.72	1.54	.75	0
XIO - normally closed contact	1.72	1.54	.75	0
OSR - one shot relay	11.48	13.02	1	0
OTE - output enable	4.43	4.43	.75	0
OTL - output latch	3.16	4.97	.75	0
OTU - output unlatch	3.16	4.97	.75	0
RES - reset	4.25	15.19	1	0
RTO - retentive on time	27.49	38.34	1	3
TOF - off timer	31.65	39.42	1	3
TON - on timer	30.38	38.34	1	3

Figure 104 Typical Instruction Times and Memory Usage for a Micrologix Controller

Typical values for an Allen-Bradley PLC-5 controller are,
input scan time ?us
output scan times ?us
housekeeping ?us
overhead memory for controller ? words

Instruction Type	Time Max (us)	Time Min. (us)	Instruction Memory (words)	Instruction Data (words)
CTD - count down	3.3	3.4	3	3
CTU- count up	3.4	3.4	3	3
XIC - normally open contact	0.32	0.16	1	0
XIO - normally closed contact	0.32	0.16	1	0
OSR - one shot relay	6.2	6.0	6	0
OTE - output enable	0.48	0.48	1	0
OTL - output latch	0.48	0.16	1	0
OTU - output unlatch	0.48	0.16	1	0
RES - reset	2.2	1.0	3	0
RTO - retentive on time	4.1	2.4	3	3
TOF - off timer	2.6	3.2	3	3
TON - on timer	4.1	2.6	3	3

Figure 105 Typical Instruction Times and Memory Usage for a PLC-5 Controller

5. Look for special program needs and check the PLC model. (e.g. PID)
6. Estimate the cost for suitable hardware, programming software, cables, manuals, training, etc., or ask for a quote from a vendor.

10.2 SPECIAL I/O MODULES

Many different special I/O modules are available. Some module types are listed below for illustration, but the commercial selection is very large. Generally most vendors offer competitive modules. Some modules, such as fuzzy logic and vision, are only offered by a few supplier, such as Omron. This may occasionally drive a decision to purchase a particular type of controller.

PLC CPU's

- A wide variety of CPU's are available, and can often be used interchangeably in the rack systems. the basic formula is price/performance. The table below compares a few CPU units in various criteria.

PLC / FEATURE	Siemens S5-90U	Siemens S5-100U	Siemens S5-115U (CPU 944)	Siemens CPU03	AEG PC-A984-145
RAM (KB)	4	<= 20	96	20	8
Scan times (us)					
per basic instruc.			0.8		5
overhead			2000		
Package	mini-module	mini-module	card	card	
Power Supply	24 VDC	24 VDC	24 VDC	115/230VAC	
Maximum Cards	6 with addon				
Maximum Racks	N/A				
Maximum Drops					
Distance			2.5m or 3km		
Counters			128		
Timers			128		
Flags			2048		
I/O - Digital					
on board	16	0	0	0	0
maximum	208	448	1024	256	256
I/O - Analog					
on board	0	0	0	0	
maximum	16	32	64	32	
Communication					
network	Sinec-L1	Sinec-L1	Sinec-L1, prop.	Sinec-L1	Modbus/Modubs+
line			printer,		
human			ASCII		
other					
Functions					
PID			option	option	option

Legend:
prop. - proprietary technology used by a single vendor
option - the vendor will offer the feature at an additional cost

Figure 106 CPU Comparison Chart

Programmers

- There are a few basic types of programmers in use. These tend to fall into 3 categories,
  1. PLC Software for Personal Computers - Similar to the specialized programming units, but the software runs on a multi-use, user supplied computer. This approach is typically preferred.
  2. Hand held units (or integrated) - Allow programming of PLC using a calculator type interface. Often done using mnemonics.
  3. Specialized programming units - Effectively a portable computer that allows graphical editing of the ladder logic, and fast uploading/downloading/monitor-

ing of the PLC.

Ethernet/modem

- For communication with remote computers. This is now an option on many CPUs.

TTL input/outputs

- When dealing with lower TTL voltages (0-5Vdc) most input cards will not recognize these. These cards allow switching of these voltages.

Encoder counter module

- Takes inputs from an encoder and tracks position. This allows encoder changes that are much faster than the PLC can scan.

Human Machine Interface (HMI)

- A-B/Siemens/Omron/Modicon/etc offer human interface systems. The user can use touch screens, screen and buttons, LCD/LED and a keypad.

ASCII module

- Adds an serial port for communicating with standard serial ports RS-232/422.

IBM PC computer cards

- An IBM compatible computer card that plugs into a PLC bus, and allows use of common software.
- For example, Siemens CP580 the Simatic AT;
  - serial ports: RS-232C, RS-422, TTY
  - RGB monitor driver (VGA)
  - keyboard and mouse interfaces
  - 3.5” disk

Counters

- Each card will have 1 to 16 counters at speeds up to 200KHz.
- The counter can be set to zero, or up/down, or gating can occur with an external input.

Thermocouple

- Thermocouples can be used to measure temperature, but these low voltage devices require sensitive electronics to get accurate temperature readings.

Analog Input/Output

- These cards measure voltages in various ranges, and allow monitoring of continuous processes. These cards can also output analog voltages to help control external processes, etc.

PID modules

- There are 2 types of PID modules. In the first the CPU does the calculation, in the second, a second controller card does the calculation.
  - when the CPU does the calculation the PID loop is slower.
  - when a specialized card controls the PID loop, it is faster, but it costs less.
- Typical applications - positioning workpieces.

Stepper motor

- Allows control of a stepper motor from a PLC rack.

Servo control module

- Has an encoder and amplifier pair built in to the card.

Diagnostic Modules

- Plug in and they monitor the CPU status.

Specialty cards for IBM PC interface

- Siemens/Allen-Bradley/etc. have cards that fit into IBM buses, and will communicate with PLC’s.

Communications

- This allows communications or networks protocols in addition to what is available on the PLC. This includes DH+, etc.

Thumb Wheel Module

- Numbers can be dialed in on wheels with digits from 0 to 9.

BCD input/output module

- Allows numbers to be output/input in BCD.

BASIC module

- Allows the user to write programs in the BASIC programming language.

Short distance RF transmitters

- e.g., Omron V600/V620 ID system
- ID Tags - Special “tags” can be attached to products, and as they pass within range of pickup sensors, they transmit an ID number, or a packet of data. This data can then be used, updated, and rewritten to the tags by the PLC. Messages are stored as ASCII text.

Voice Recognition/Speech

- In some cases verbal I/O can be useful. Speech recognition methods are still very limited, the user must control their speech, and background noise causes problems.

10.3 SUMMARY

- Both suppliers and products should be evaluated.
- A single supplier can be advantageous in simplifying maintenance.
- The time and memory requirements for a program can be estimated using design work.
- Special I/O modules can be selected to suit project needs.

10.4 PRACTICE PROBLEMS

10.5 ASSIGNMENT PROBLEMS

1. What is the most commonly used type of I/O interface?

2. What is a large memory size for a PLC?

3. What factors affect the selection of the size of a PLC.