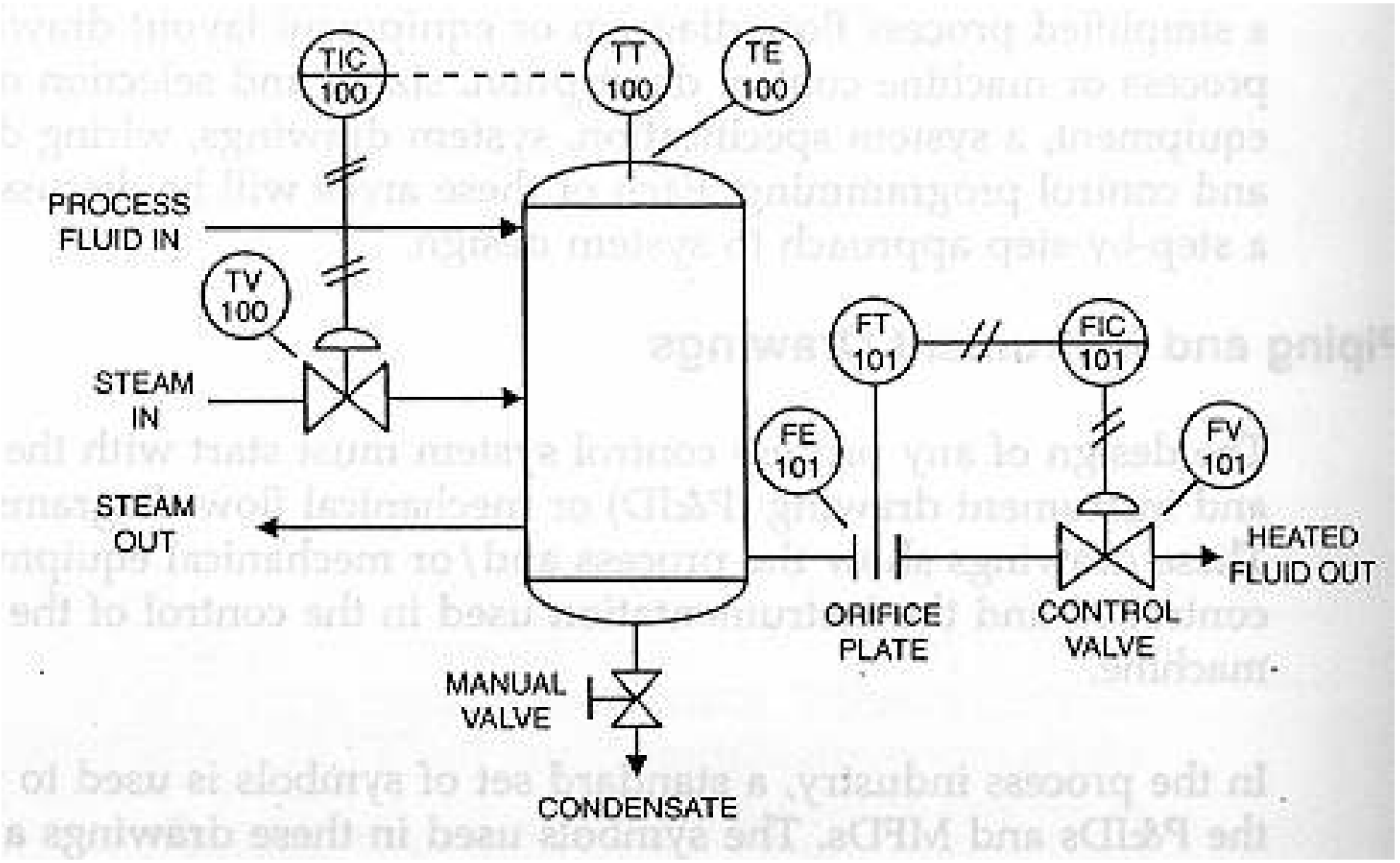
PLC System Design

1. Process Description
2. I/O Sizing
3. Memory Sizing
4. Selecting programming language
5. Peripheral requirements
6. System drawing and I/O wiring diagrams
7. System programming

Process Description

- States the purpose and the steps of the process/plant operation
- Process Description is the most important step in the design process
- Bridge of communications between the user and the designer
  - Piping and Instrument Diagram (P&ID) and Mechanical Flow Diagrams (MFDs)
  - Simplified drawing that shows only the equipment and instrumentation controlled or measured by the PLC is required
  - This drawing will be used to show the status of the process in each step or state to aid in the programming of the system

Piping & Instrument Diagram (P&ID)



I/O Sizing (1)

- Estimate the number of input/output (I/O) required to control the process
  - Obtain the number of device from P&ID diagram
  - Add the number of I/O points from each devices to obtain total I/O points
- Consider different types of I/O :
  - Discrete AC/DC : Limit switches, push buttons, selector switches, solenoid, etc.
  - TTL : solid state displays and electronic instrumentation
  - Analog : Level transmitter, pressure transmitter, etc.
  - Encoders

I/O Sizing (2)

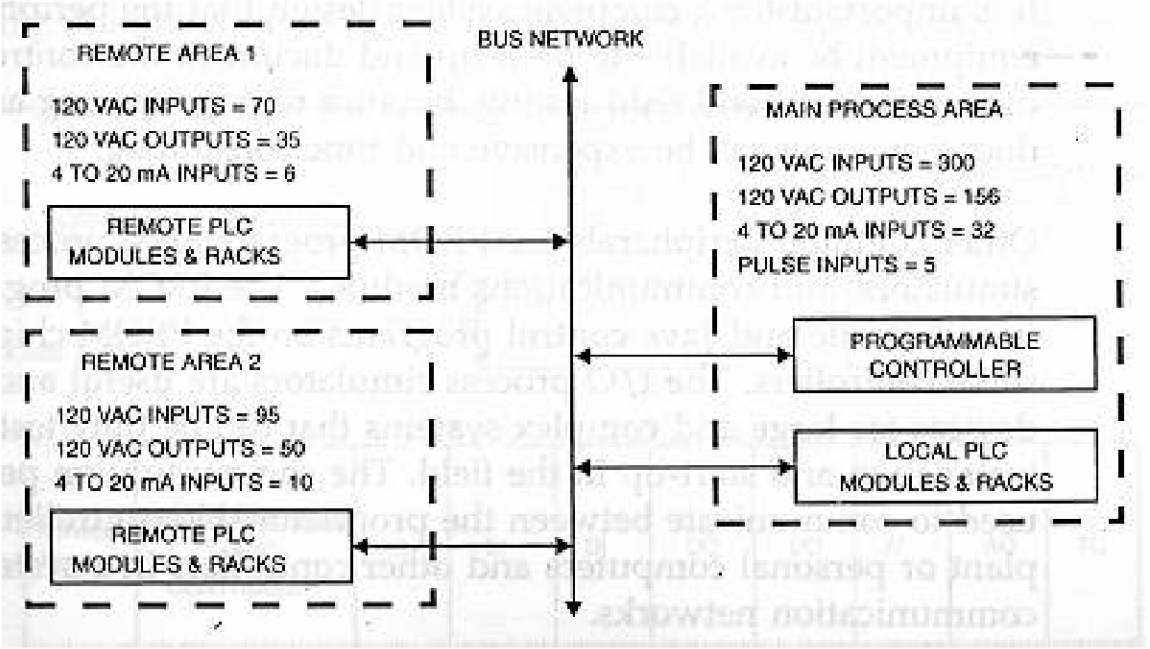
- Select PLC size :
  - *Micro* : up to 32 I/O points
  - *Small* : 32 - 256 I/O points
  - *Medium* : 256 - 1024 I/O points
  - *Large* : > 1024 I/O points
- Estimate the number of I/O module
  - Classify each type of I/O points (discrete, analog, isolated, TTL, dry contact)
  - Select suitable I/O modules from PLC manual and obtain the number of I/O points per module
  - The number of each I/O module type required = *[Total I/O points] / [Number of I/O points per module]*
- Add spare and future expansions (10-20% spare capacity)

Memory Sizing

- The amount of memory required depends on :
  - control program complexity
  - the number of I/O points
- Precise (*almost impossible*) method to determine memory size :
  - Write out the control program
  - Count the number of instructions used
  - Multiply this count by the number of words used per instructions (obtained from PLC programming manual)
  - Add the amounts of memor used by executive programs and the processor overhead
- **Practical method** :

  Total memory = 10 x [the number of I/O points]

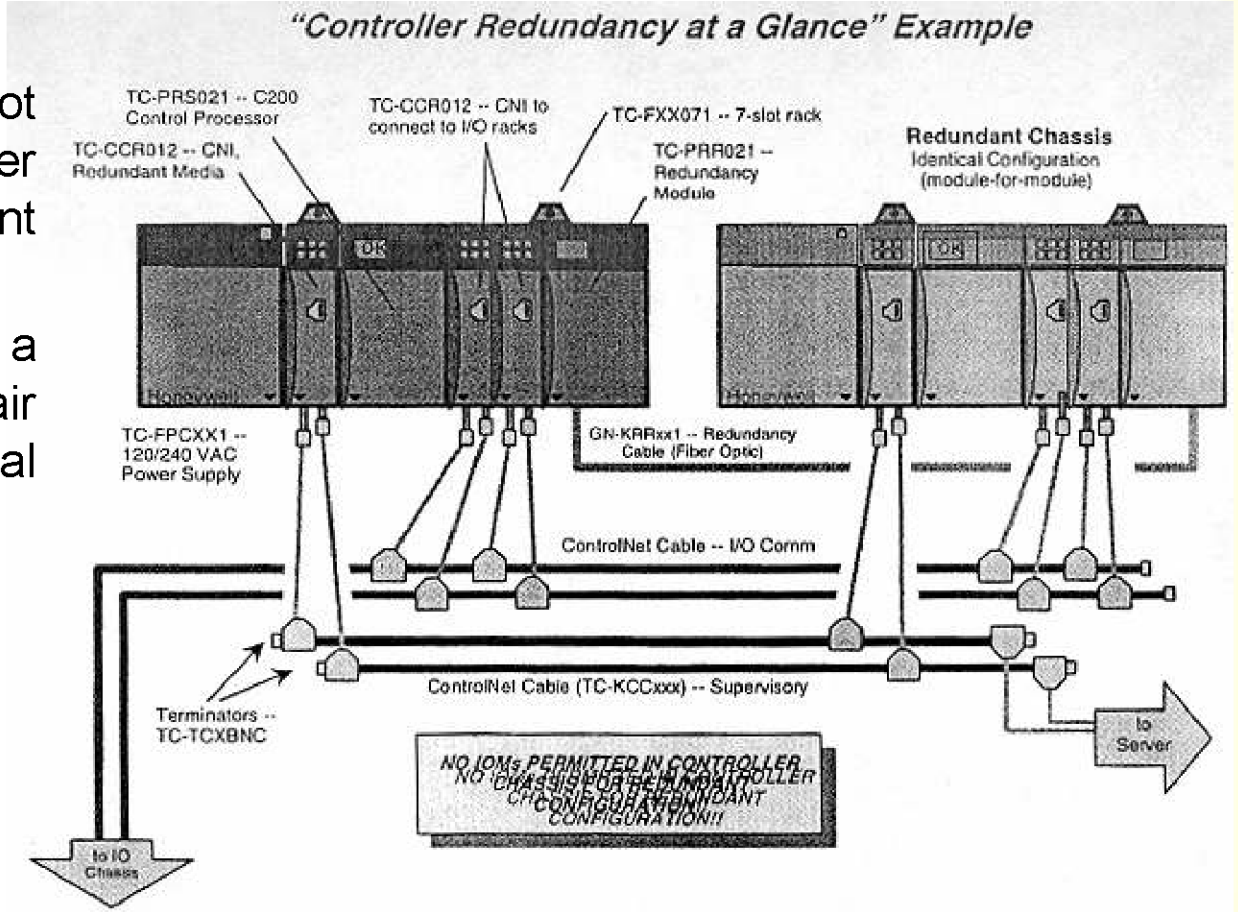
I/O and Memory Sizing Example



- I/O Points
  - Remote Area 1 : I/O = 70 + 35 + 6 = 111
  - Remote Area 2 : I/O = 95 + 50 + 10 = 155
  - Main Process Area : I/O = 300 + 156 + 32 + 5 = 493
  - Total I/O points = 759
  - Spare points = 10% x 759 = 76
- PLC size = Medium-sized (1024 I/O points max.)
- Memory size = 10 x 759 = 7590 or 8K

Redundant Configuration

- I/O modules are not permitted in either chassis of a redundant chassis pair
- Both chassis of a redundant chassis pair must have identical slot-for-slot configurations



Selecting Programming Language

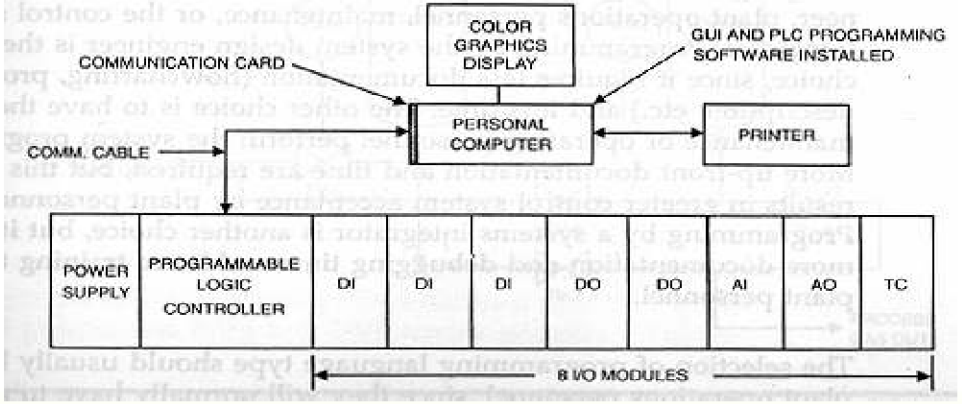
- Most PLCs offer the basic ladder logic instructions plus a combination of the other types of languages
- Programming language selections is depends on :
  - Complexity of the control system
  - Background knowledge of the control system programmers and operators

Peripheral Requirements

- Peripheral = other equipment in the PLC system that is not directly connected to field I/O devices
  - Compact portable programming device from PLC manufacturer
  - Portable PC with PLC software
  - Magnetic tape storage unit to store control program
  - PROM Programmer
  - Process I/O simulators
  - Communications modules
    - Depends on plant network design
    - Extra modules is required for integration within different brands
  - Operator interfaces
    - Hard-wired local and main control panels
    - GUI software runs on a personal computer
    - Intelligent peripheral devices such as touch screen
    - Industrial PC with function keys and GUI software

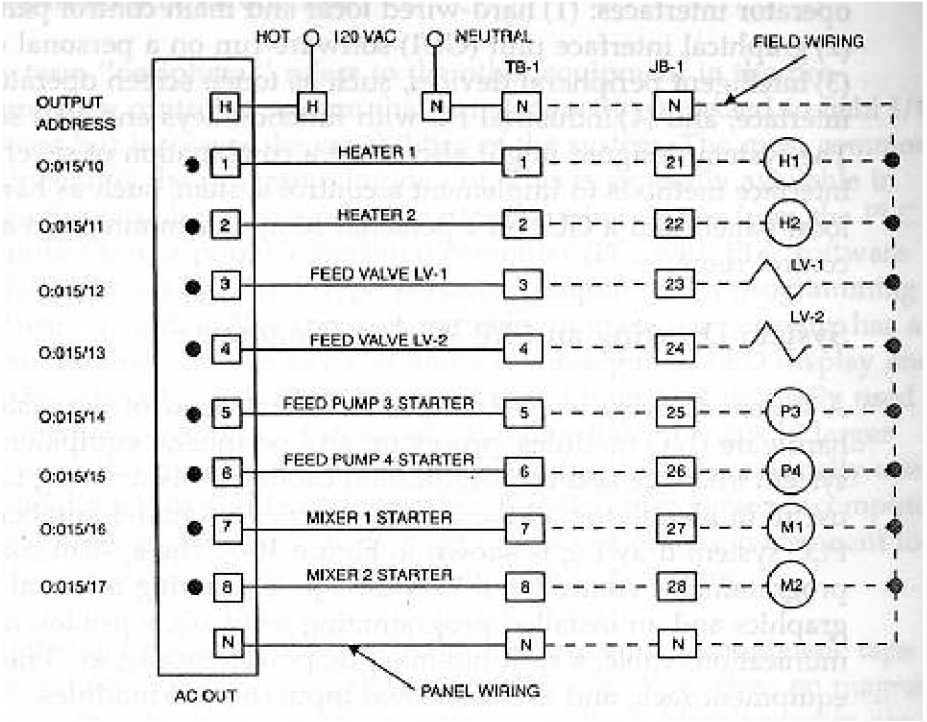
System Drawing

- Gives an overall view of the system hardware
  - I/O modules
  - processor
  - peripheral equipment
  - system interface
  - communication cabling
- Useful in identifying all the interface cables by model number



Example of I/O Wiring Diagrams

- Field wiring is normally indicated by a dashed line
- PLC output addresses are given on the left-hand side
- TB = Terminal Box
- JB = Junction Box



System Programming

- Person involved in system programming :
  - System design engineer
  - Plant operations personnel
  - Maintenance personnel
  - Control system integrator
- Programming by system design engineer takes less time and require less documentation (flowcharting, process description, etc.)
- Selection of programming language type should usually be left to plant operations personnel for easier maintenance and troubleshooting