Special Function I/O

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Introduction to Special I/O Modules

- Special function I/O interfaces provide the link between programmable controllers and devices that require special types of signals.
- These special signals, which differ from standard analog and digital signals, are not very common, occurring in only 5–10% of PLC applications.
- Divided into two categories:
  - Direct action interfaces
  - Intelligent I/O interfaces
    - Contain on-board processors

Introduction to Special I/O Modules

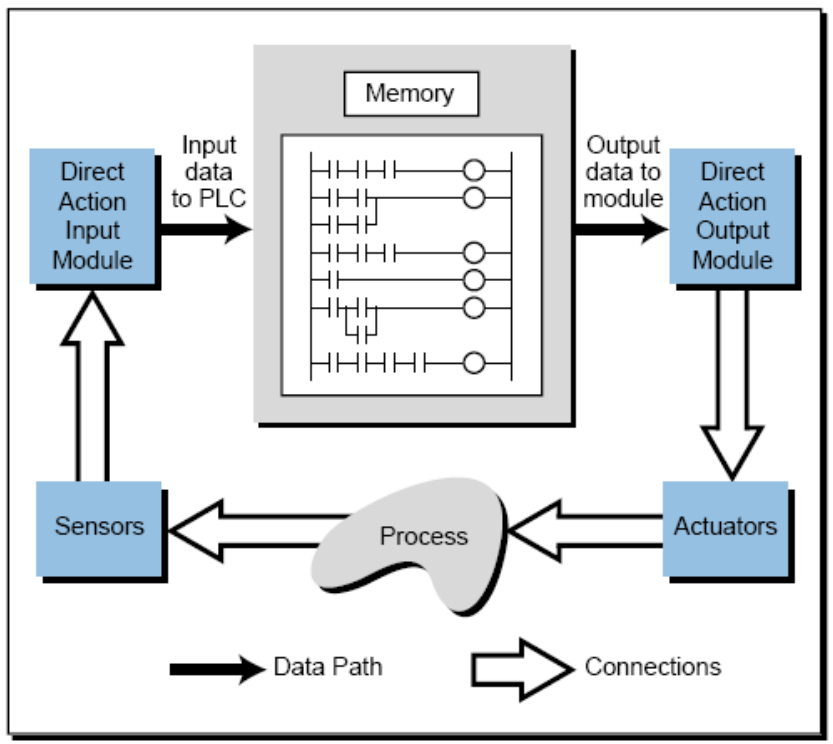


Figure 8-1. Direct action I/O interface application.

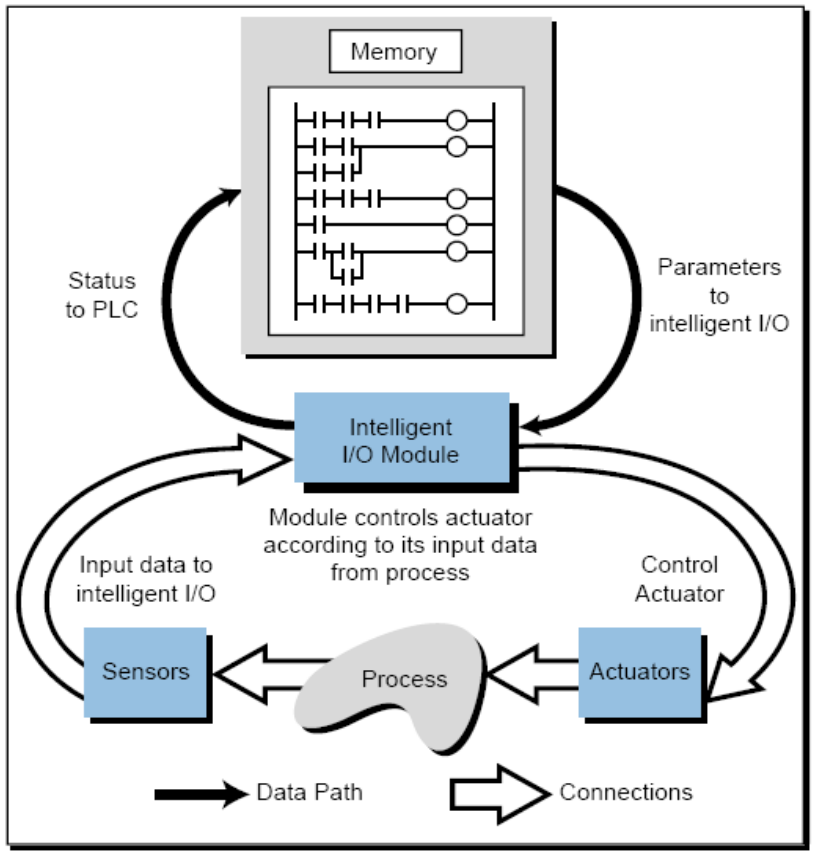


Figure 8-2. Intelligent I/O interface application.

Special Discrete Interfaces

- Fast-Input /Pulse-Stretcher Modules
  - Some devices generate signals that are faster than PLC scan time
  - Special modules are enable signals to remain valid for one scan
  - Example: some proximity switches have pulse duration 50→100 μs
- Fast-Response Interfaces
  - Extensions to fast-input modules
  - The speed of response is fast an independent of PLC speed
  - Example: Feeder jam in high-speed production line
- Wire Input Fault Modules
  - Detect short or open-circuit connections between module & devices
  - Used for critical input connections
  - Interface sends 6 mA when OFF and 20 mA when ON.

Special Analog Interfaces

- Weight input modules
- Temperature input modules
- PID modules

Weight Input Modules

- **Weight input modules** are special types of analog interfaces designed to read data from load cells.

- A weight input module provides the excitation voltage for load cells, as well as the necessary software for calibrating load cell circuits.

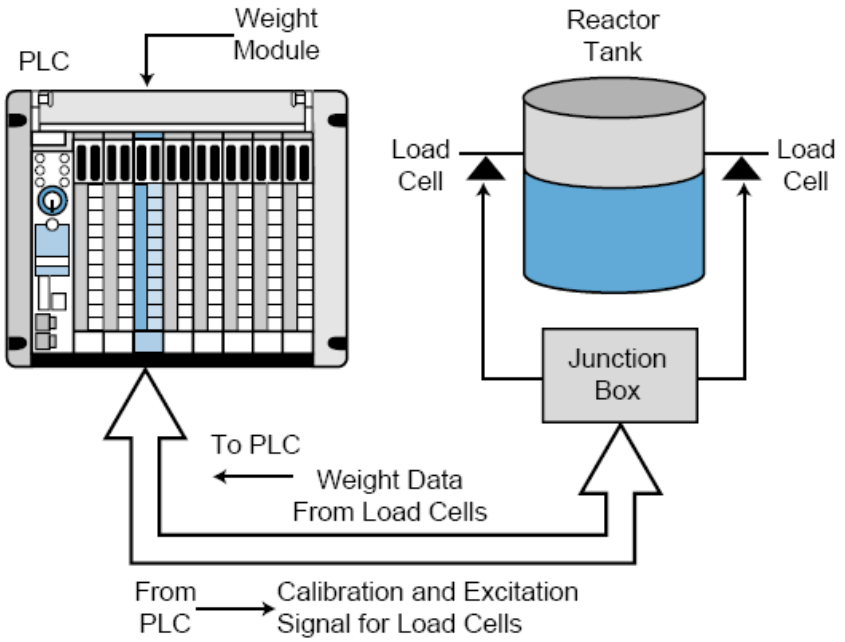


Figure 8-9. Weight input application configuration.

Thermocouple Input Modules

- Accept millivolt signals from thermocouple transducers
- The module amplifies, digitizes, and converts the input signal into a digital signal.
- Thermocouples exhibit nonlinearities along their range.
- On-board microprocessor calculates the temperature that corresponds to the voltage reading
- Thermocouple interfaces usually provide **cold junction compensation** and **lead resistance compensation**

PID Modules

- **Proportional-integral-derivative (PID) interfaces** are used in process applications that require continuous closed-loop control employing the PID algorithm.
- The PID module receives the process variable in analog form
- A PID module receives primarily control parameter and set point information from the main processor.
- During operation, the PID interface maintains status communication with the main CPU, exchanging module and process information

PID Modules

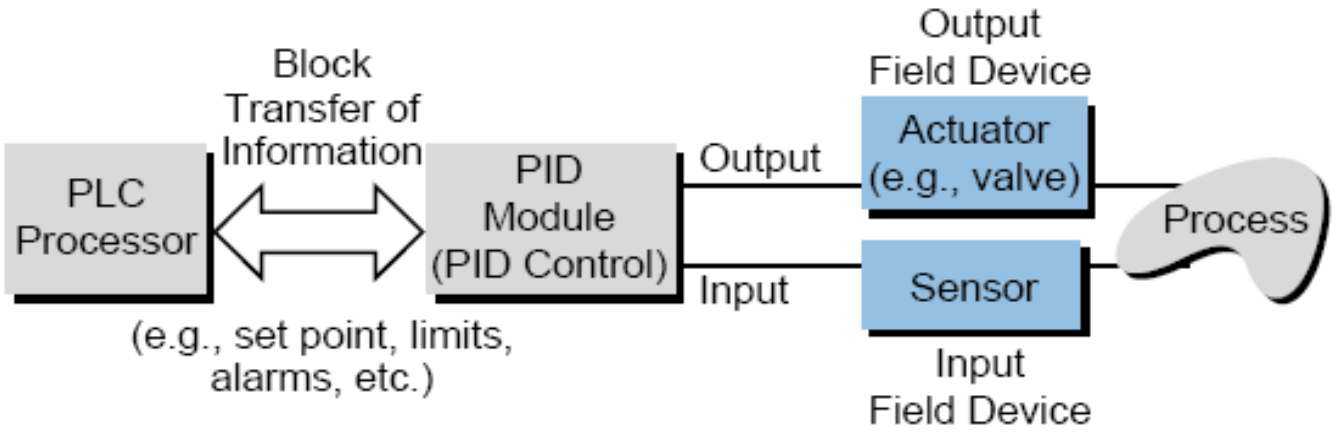


Figure 8-13. Block diagram of PID control.

PID Modules

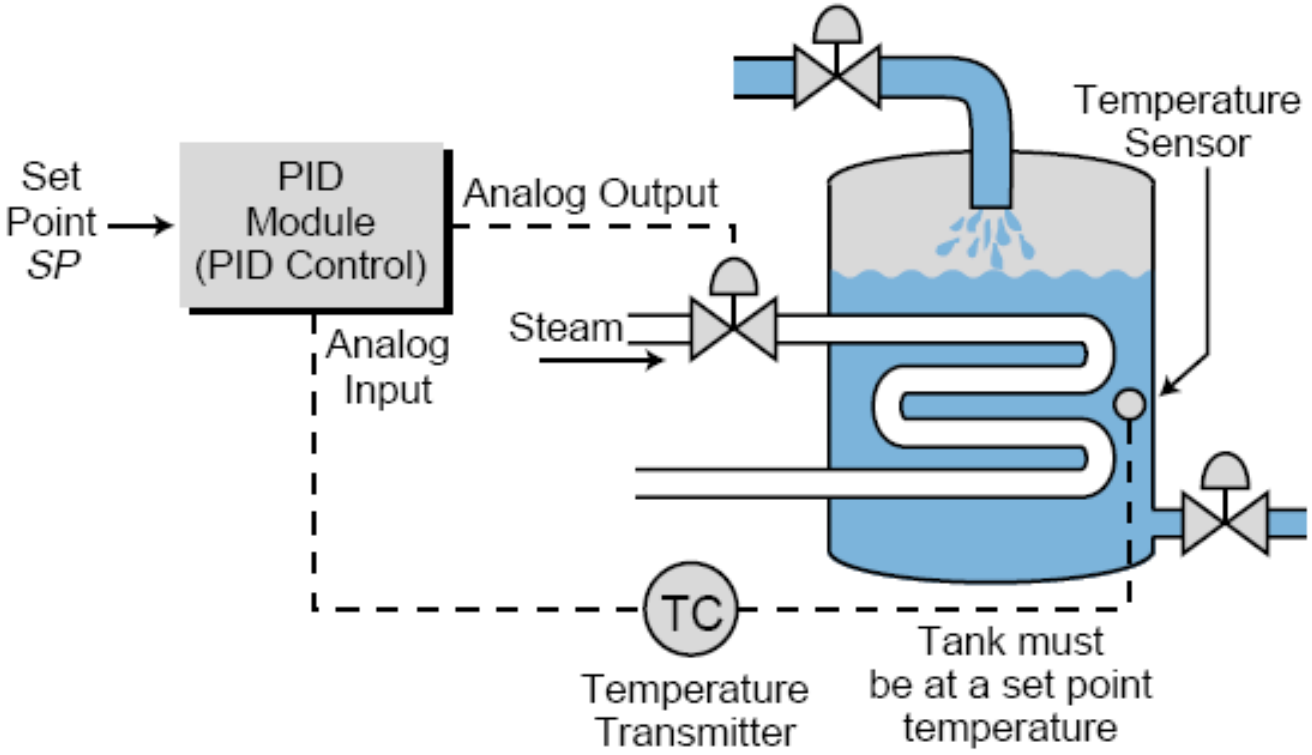


Figure 8-14. Illustration of a PID control process.

PID Modules

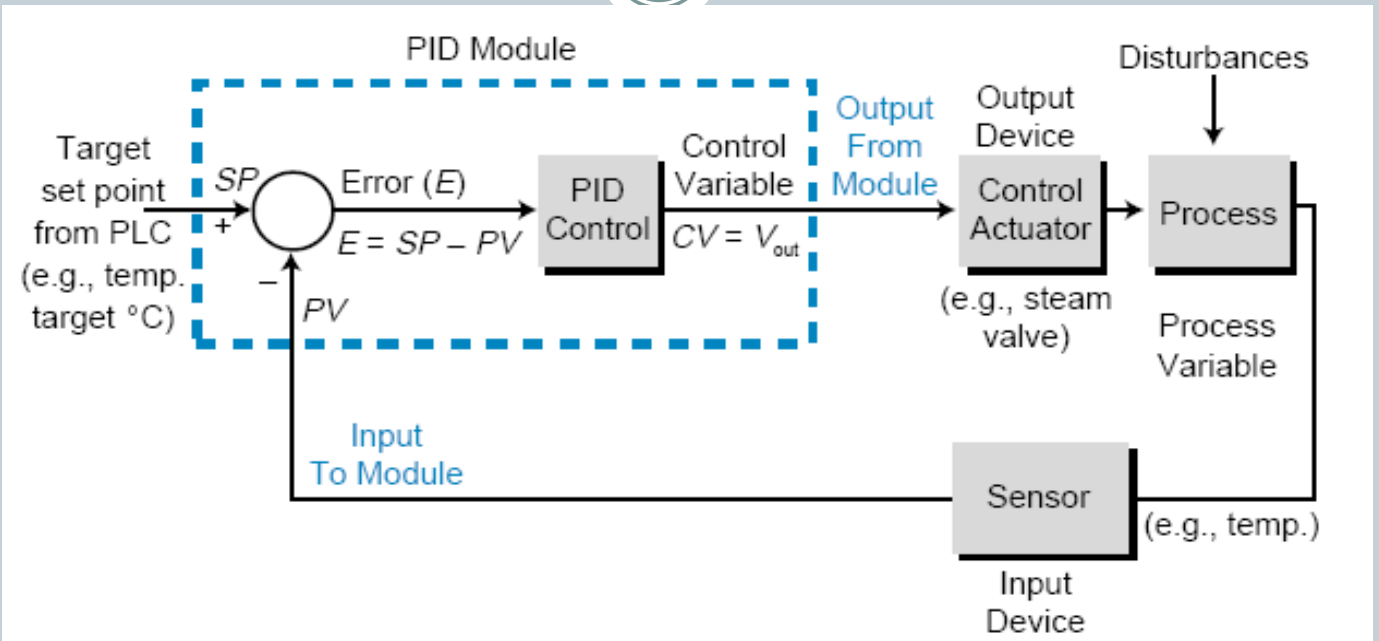


Figure 8-15. Closed-loop process control.

$$V_{out} = K_P E + K_I \int E dt + K_D \frac{dE}{dt}$$

PID Modules

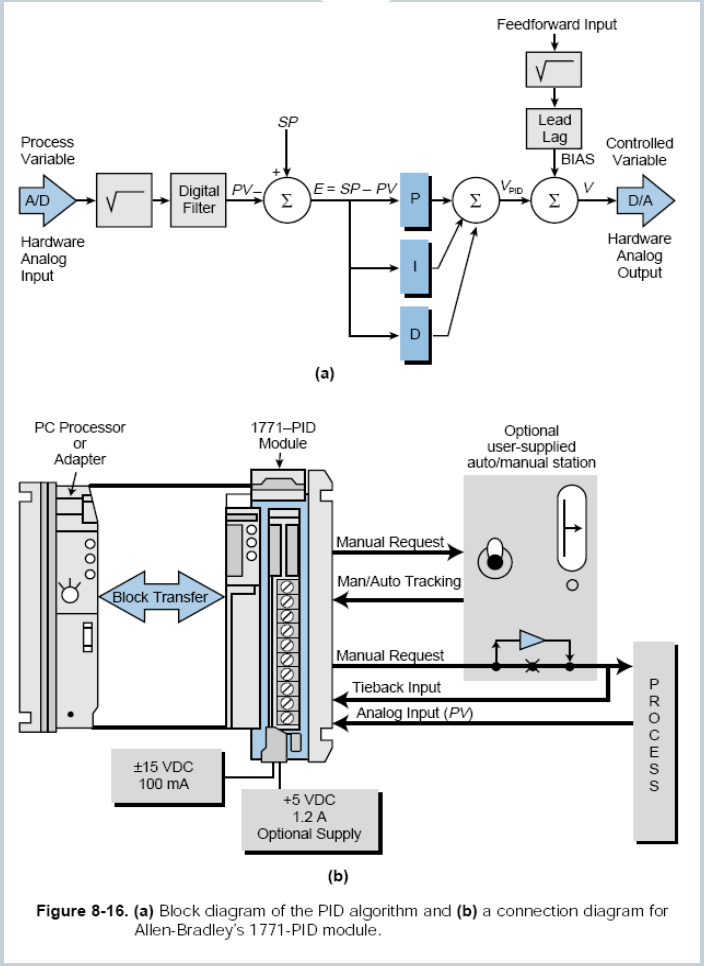


Figure 8-16. **(a)** Block diagram of the PID algorithm and **(b)** a connection diagram for Allen-Bradley's 1771-PID module.

Positioning Interfaces

- Positioning interfaces are intelligent modules that provide position-related feedback and control output information in machine axis control applications.
- Positioning interfaces use PLC instructions that transfer blocks of data at a time.
- This data includes initialization parameters, distances and limits, and velocities.
- Instructions, such as block transfer in/out and move data in/out, are typically used to implement this transfer of information.

Positioning Interfaces

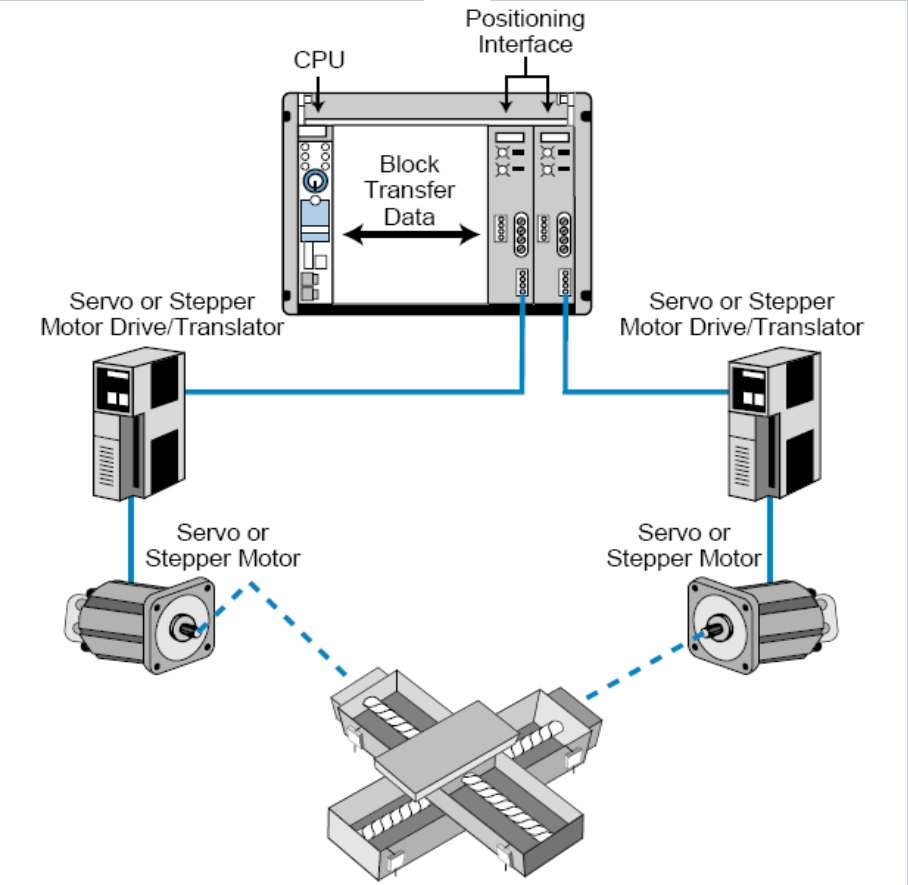


Figure 8-18. Positioning interface configuration.

Encoder / Counter Interfaces

- **Encoder/counter modules** interface encoders and high-speed counter devices with programmable controllers.
- These module operate independently of the processor and I/O scan.
- An encoder/counter module is an integral part of a programmable controller system when it is used in applications requiring position information.
- Applications include closed-loop positioning of machine tool axes and conveyors, as well as cycle monitoring of high-speed machines.
- There are two types of encoder/counter interfaces: absolute and incremental.
- The communication between an encoder/counter interface and the processor is bidirectional.

Encoder / Counter Interfaces

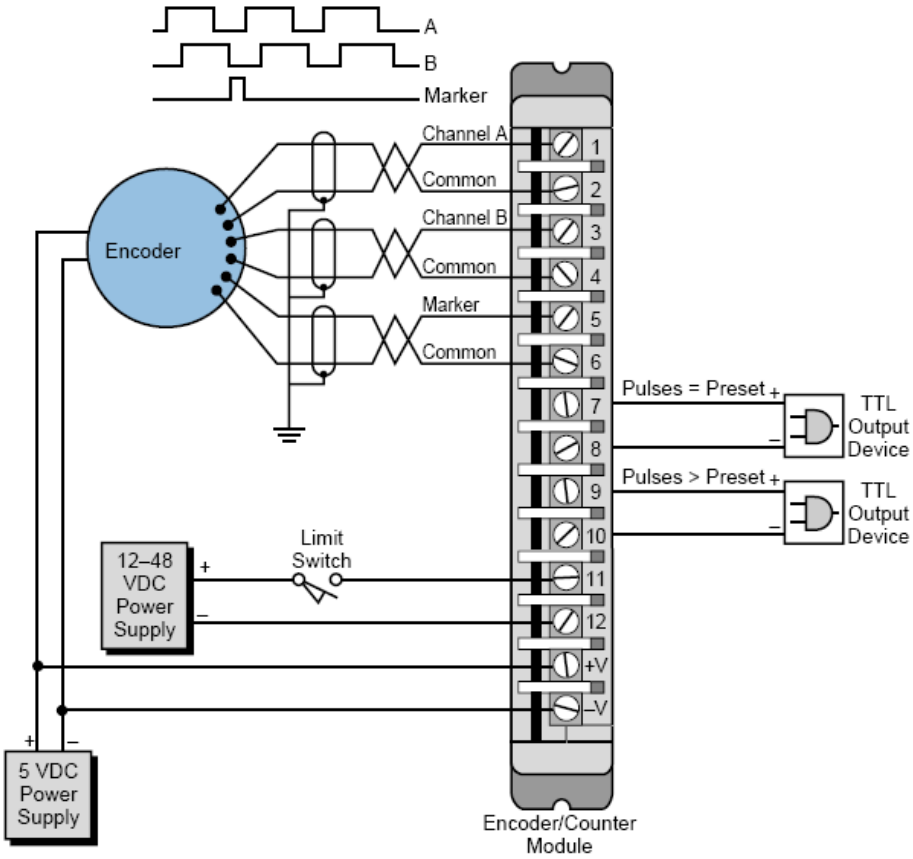


Figure 8-19. Encoder/counter interface connection diagram.

Stepper Motor Interfaces

- Stepper motors are permanent-type magnet motors that translate incoming pulses, through a stepper translator, into mechanical motion.
- The motion of a stepper can be accelerated, decelerated, or maintained constantly by controlling the pulse rate output from a stepper module.
- A stepper motor's motion follows the number of input pulses.
- The ability to respond to a fixed input enables the system to operate in an open-loop mode, leading to cost savings in the total system.
- A stepper interface generates a pulse train that is compatible with the stepper translator, indicating distance, rate, and direction commands to the motor.

Stepper Motor Interfaces

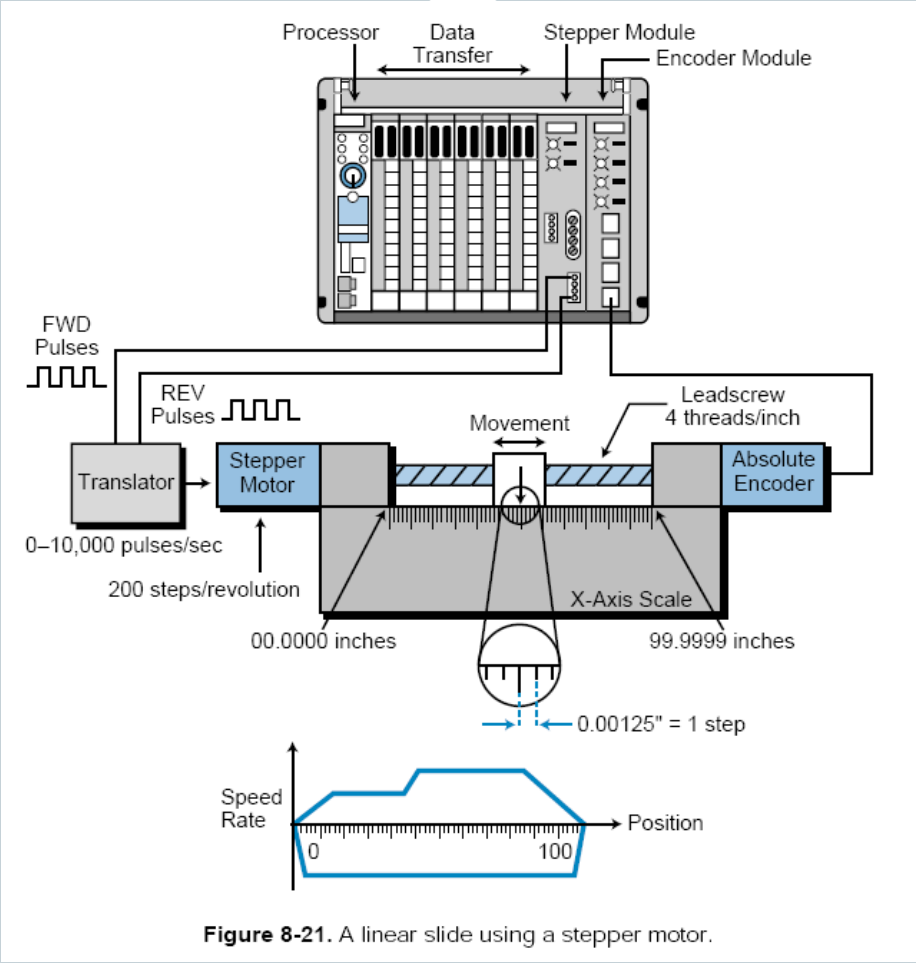


Figure 8-21. A linear slide using a stepper motor.

Stepper Motor Interfaces

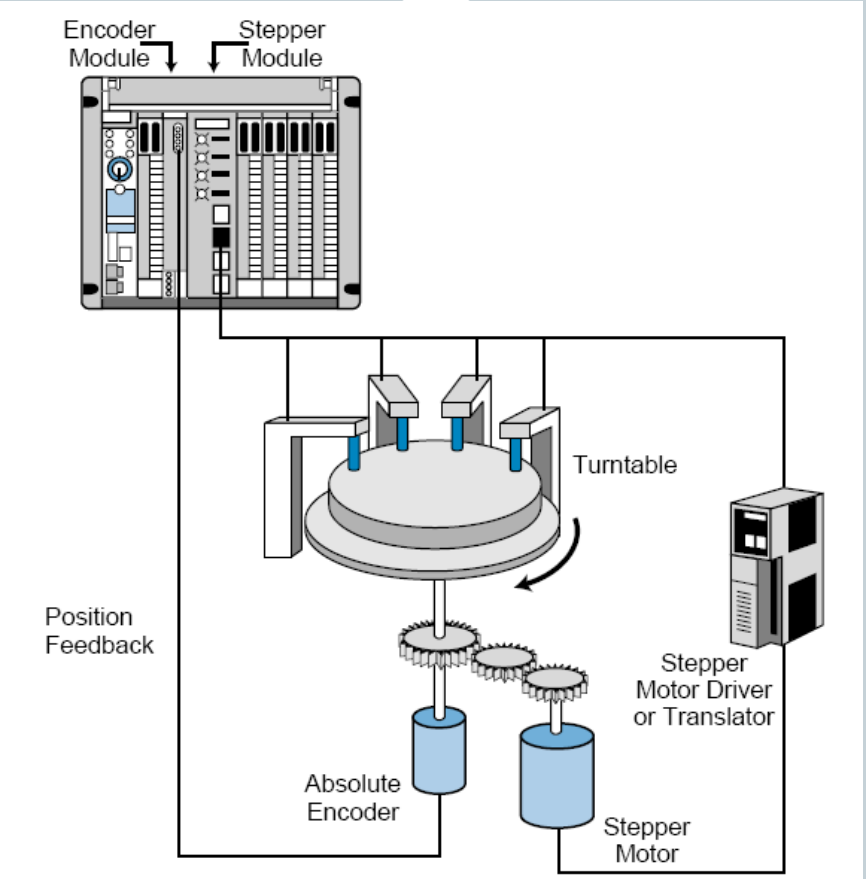


Figure 8-26. Stepper motor with a position/velocity feedback scheme.

Servo Motor Interfaces

- A servo motor is a specially designed motor that contains a permanent magnet.
- The speed of a servo motor can be easily varied by changing the input voltage to the motor.
- A servo module provides the drive controller with a ±10 VDC signal, which defines the forward and reverse speeds of the servo motor.
- Servo positioning controls operate in a closed-loop system, requiring feedback information in the form of velocity or position.

Servo Motor Interfaces

- Advantages of servo control include short positioning time, high accuracy, and reliability.

- Applications include grinders, metal forming machines, transfer lines, material-handling machines, and the precise control of servo driver valves in continuous process applications.

Servo Motor Interfaces

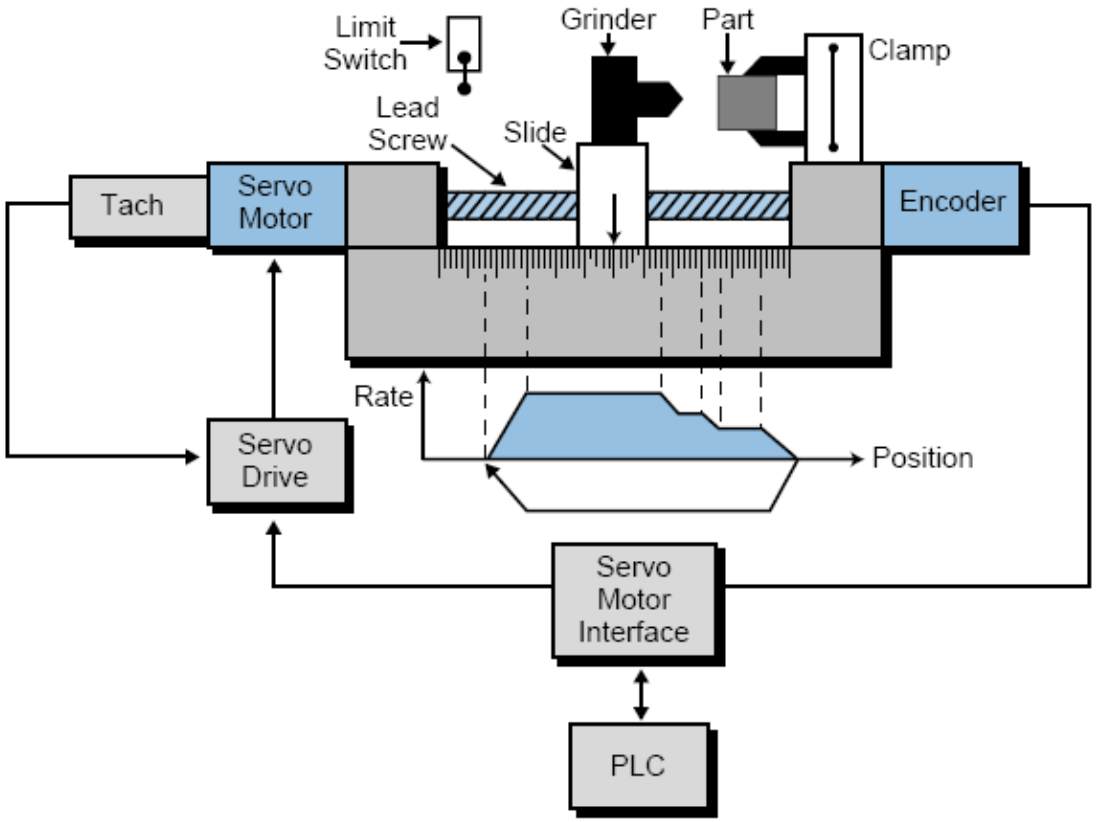


Figure 8-28. Servo motor interface application.

Servo Motor Interfaces

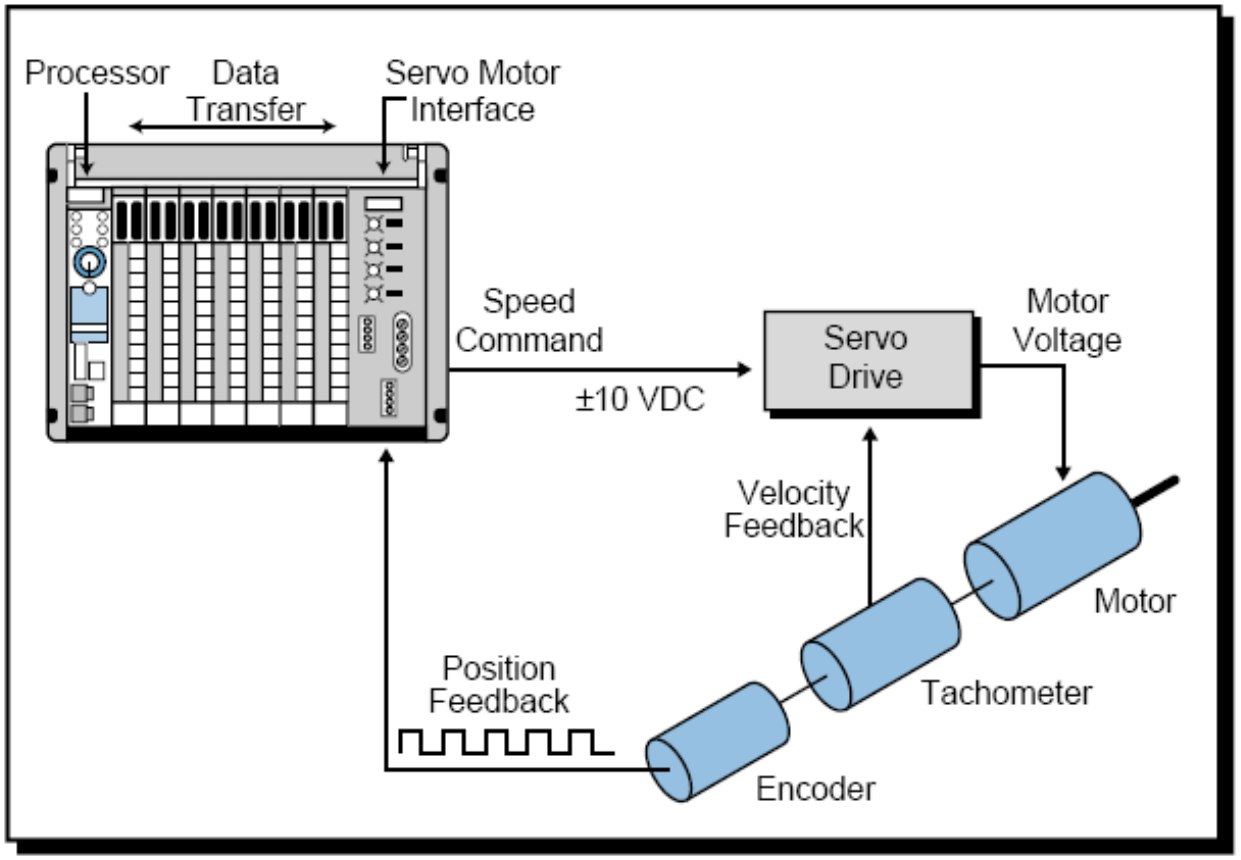


Figure 8-29. Servo control block diagram.

Servo Motor Interfaces

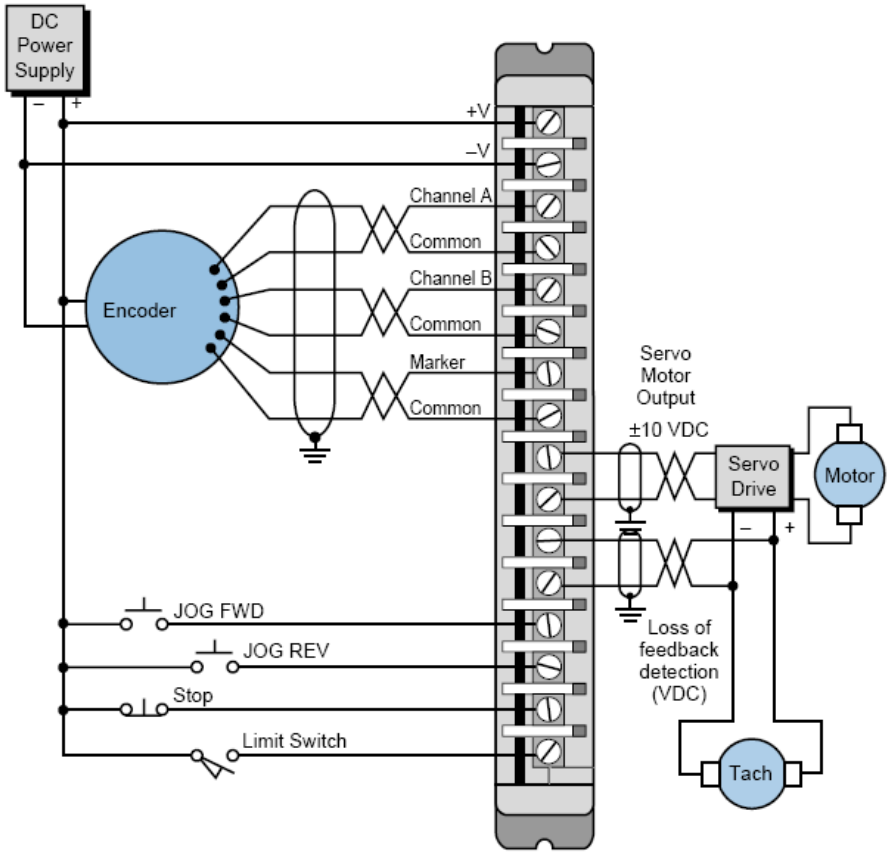


Figure 8-31. Servo motor interface connection diagram.

ASCII, Computer, and Network Interfaces

- Special I/O modules aid in the communication of information to the real world.
- These intelligent modules accept data from and transmit data to field devices, including computers and other PLCs.
- This data is transmitted in one of the following forms:
  - ASCII characters
  - A computer language, such as BASIC or C
  - A proprietary media, as in the case of a network

ASCII

- **ASCII input/output interfaces** send and receive alphanumeric data between peripheral equipment and the controller.
- Typical peripheral devices include printers, video monitors, and displays.
- The information exchange in either type of interface generally takes place via an RS-232C, RS-422, RS-485, or a 20 mA current loop standard communications link

Computer Modules -- BASIC

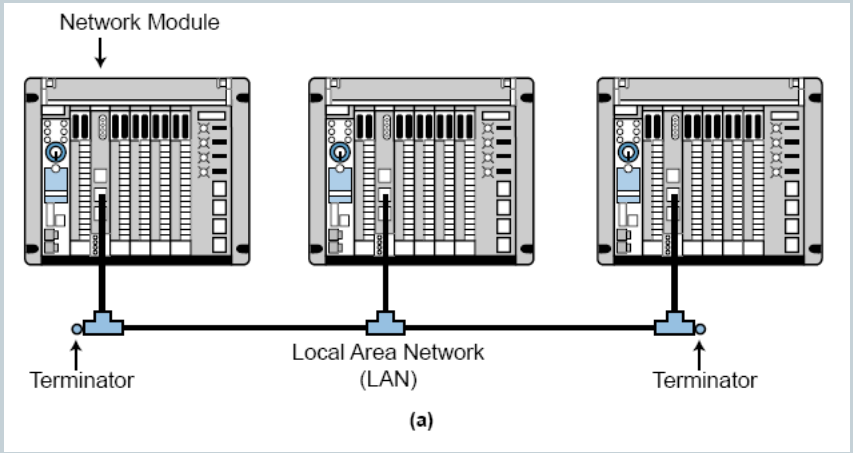
- **BASIC modules** are intelligent I/O interfaces capable of performing computational tasks without burdening the PLC processor's computing time.
- BASIC module does not actually command or control specific field devices. Rather, it complements the performance of the PLC system.
- Some data-processing modules are able to run languages other than BASIC, such as PASCAL, C, or other high-level languages.

Network Interface Modules

- **Network interface modules** allow a number of PLCs and other intelligent devices to communicate and pass PLC data over a high-speed local area communication network.

- The most popular networks are:
  - device-level bus networks (e.g., CANbus, Seriplex, etc.), which are used by discrete devices
  - process field networks (e.g., Fieldbus and Profibus), which are used by analog devices
  - Ethernet/IEEE 802.3 networks, used by PLC CPUs and computers
  - proprietary networks, which are widely used by large PLC manufacturers

Network Interface Modules



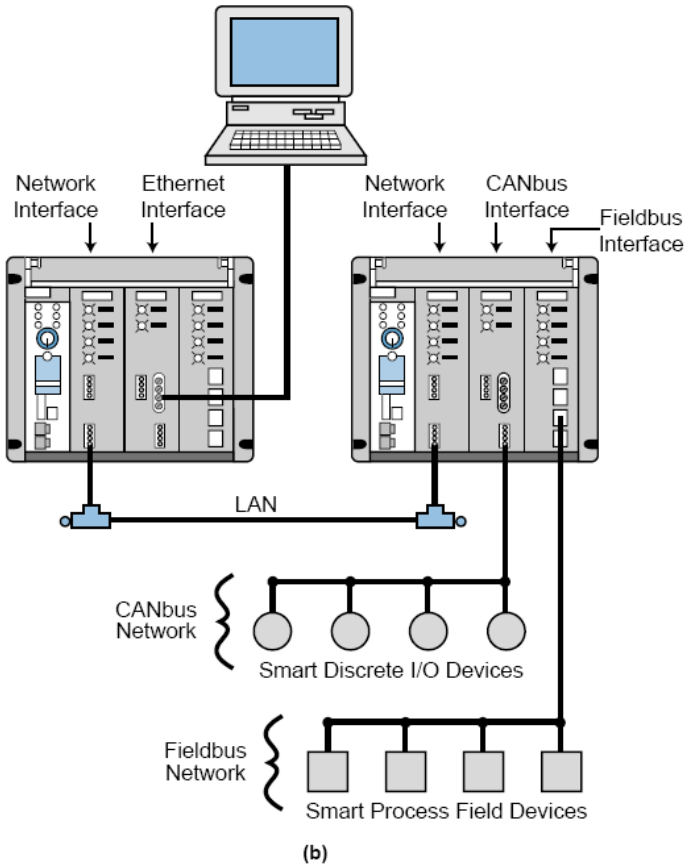


Figure 8-35. (a) A standard PLC local area network and **(b)** a PLC local area network with CANbus (device bus) and Fieldbus (process bus) subnetworks.

Fuzzy Logic Interfaces

- **Fuzzy logic interfaces** implements fuzzy logic algorithms in PLCs.

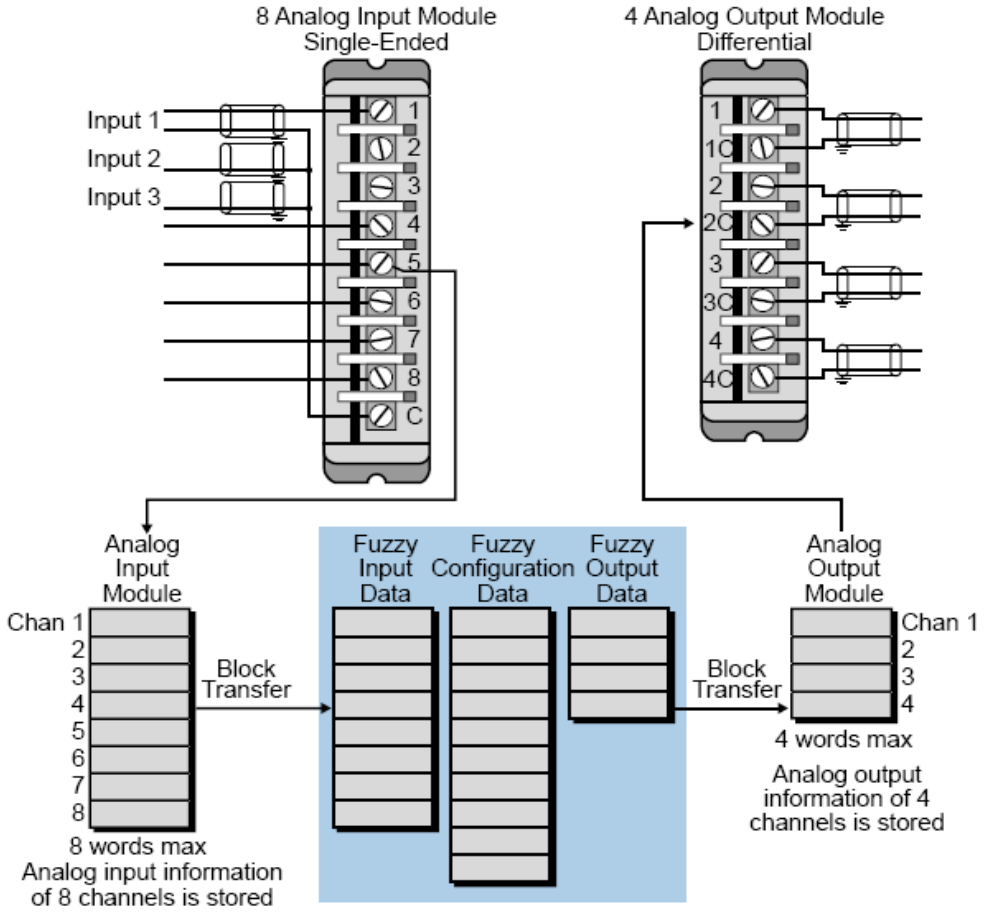


Figure 8-42. Data transfer between I/O modules and fuzzy module.

Serial Communication

- **Serial communication** occurs in serial form through simple, twisted-pair cables.
- Serial data transmission is used for most peripheral communication devices.
- Serial communication allows peripheral equipment, such as terminals, modems, operator interface panels, and line printers, to receive ASCII information.
- Two of the most popular standards for serial communication are the RS-232C and the 20 mA current loop. Other PLC standards are the RS-422 and RS-485.