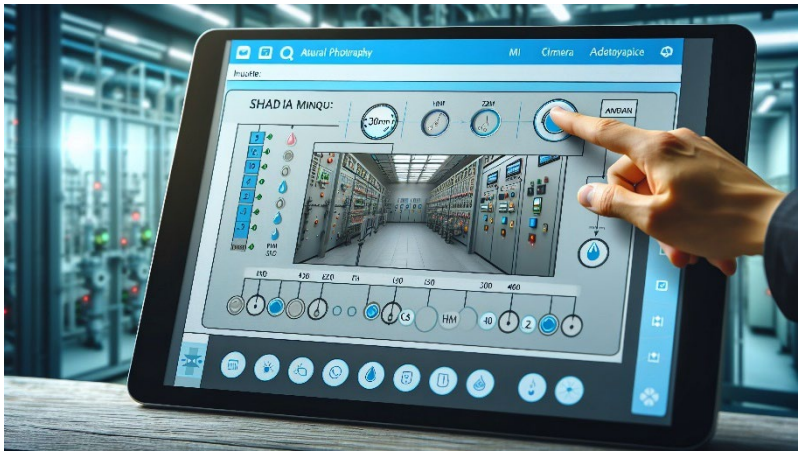
Overview

Programmable Logic Controllers (PLCs) are ruggedized industrial computers used to control and monitor industrial equipment based on custom programming. These controllers can automate a specific process, machine function or even an entire production line. PLCs come in many different sizes and form factors. A PLC controls a wide range of functions on the factory floor by monitoring analog or digital data via input modules, such as sensors and switches, and execute a series of functions via output modules to control the state of output devices, such as alarms, actuators, motors, valves, etc. In addition to process control, PLCs are integral to data acquisition and communication. There may also be one or multiple communication interfaces to other terminals in the system. In compact PLCs, CPU control and input/output interfaces are housed in the same enclosure. Distributed PLC systems typically have control distributed across many operational and physical areas adding control autonomy, flexibility and intelligence on site. In any case PLC systems provide for flexibility purposes modular expansion options to match the number of inputs and outputs required. The Human Machine Interface to the system is typically through an interactive touch panel. The HMI will have many of the same memory requirements as the controller itself.

PLC Automated System Illustration



Human Machine Interface (HMI) Panel

PLC systems manage real-world inputs/outputs and operate deterministically within set time limits. If the output is delayed, unpredicted behavior will result, which might directly impact efficiency and create negative consequences. Since it is also used closed to the factory floor, a PLC must be robust to withstand harsh environmental conditions. In addition, a successful design must provide reliability and system stability. Power losses pose a significant risk, especially with volatile memory (RAM). An unexpected power outage can lead to data loss. To prevent

this, the use of Uninterruptible Power Supplies (UPS) and storage of critical data in non-volatile memories are very common practices.

This article addresses how non-volatile store capabilities and fast access time of Everspin Technologies MRAM play a significant and strategic role in modern, high-performance PLC systems.

A block diagram of the physical arrangement of a PLC is shown in Figure 2. Not all the items shown in this diagram are present in every PLC, but this will provide an idea of a typical configuration.

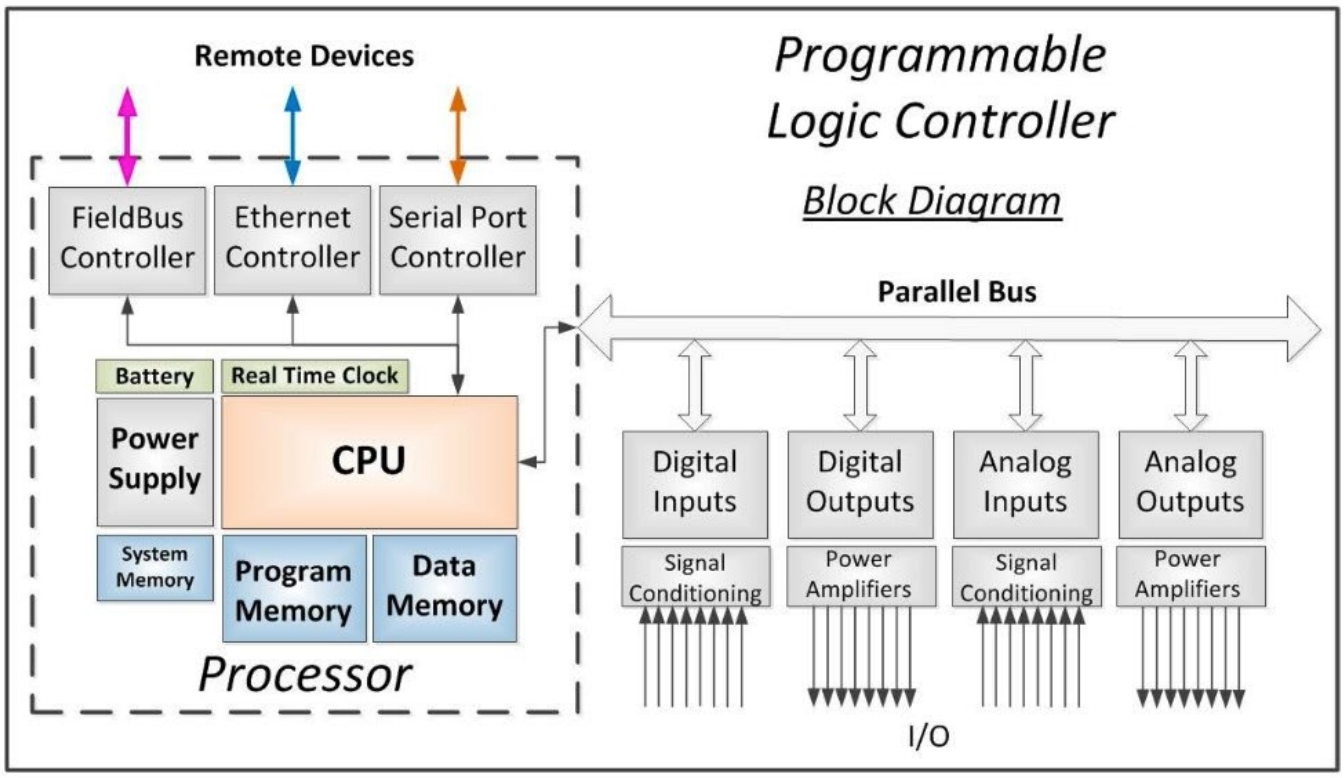


Figure 1: Example of a PLC layout and its various components. Courtesy: Automation LLC

The use of non-volatile memory in PLC

PLCs employ a mix of volatile and non-volatile memory. Data storage, program execution and I/O management are distinct yet interdependent functionalities. Non-volatile memory refers to a type of memory that retains its stored information even when the power is removed. It is commonly used to hold the initial instructions executed by a computer when it is turned on, known as the boot code. When the PLC is powered on, the program is loaded from non-volatile memory into the user memory of the controller. Not all PLC platforms back up the user memory with a battery or other energy storage device and data memory may be lost when a processor loses power. Some others ensure that the data is kept intact even when the power is lost by using battery-backed SRAM, nvSRAM or MRAM. This means the values in data registers will be retained and the program will start in its last known state. But it is not only this. Since customer configurations and system state information must be protected and instantly

retrievable under any circumstances, PLC design requires a non-volatile memory (NVM), which maintains data when power is lost or interrupted.

However, the memory must not only be non-volatile; it must also be able to withstand constant updating and retain data under high temperatures for extended periods of time. Everspin Technologies MRAM is the memory of choice for PLC manufacturers due to its unique combination of attributes that meet the need for data protection, fast access times, high write cycle endurance and long data retention – all in one memory device.

Everspin Technologies MRAM's key features include:

- A minimum of ten years of data retention across the entire temperature range.
- Virtual unlimited writes over the life of the customer system.
- Byte level writes and reads with no erase required.
- Data Integrity: no external ECC required.
- 400 Mbytes of read and write bandwidth for the most recent industrial xSPI STT-MRAM.
- Extended Industrial operating temperature range of -40°C to 105°C.
- MRAM is available in a wide range of densities, from 128Kb up to 128Mb.
- No need to use external and bulky batteries or super capacitors to retain the data.
- Use of a reduced number of external components around the MRAM, providing PLC system size and cost reduction.
- Not vulnerable to moisture, shock and vibration.
- Long product life cycle

HIGH PERFORMANCE	***RELIABLE***	***PRODUCT FEATURES***
200MHz Octal SPI, with DTR	*Unlimited read and write operations*	*-40°C to 85°C Industrial and -40°C to 105°C Extended Industrial Grades*
400MB/s Bandwidth	*No wear-leveling required*	*High Data Integrity: No external ECC required*
No write delays	*10 years data retention*	*Byte level writes and reads with no erase required*
Low power	*No battery or capacitor required*	*NOR emulation mode with XIP commands*

Table 1 Key Features of EMxxLX xSPI MRAM

Typical Octal xSPI STT-MRAM interface connection

Figure 2 shows the EM064LX 64Mb xSPI STT-MRAM connection in Octal SPI mode with a system memory controller for a typical PLC application. At a clock frequency of 200MHz, the memory can deliver 400MB/s of bandwidth for both reads and writes when configured in DTR mode.

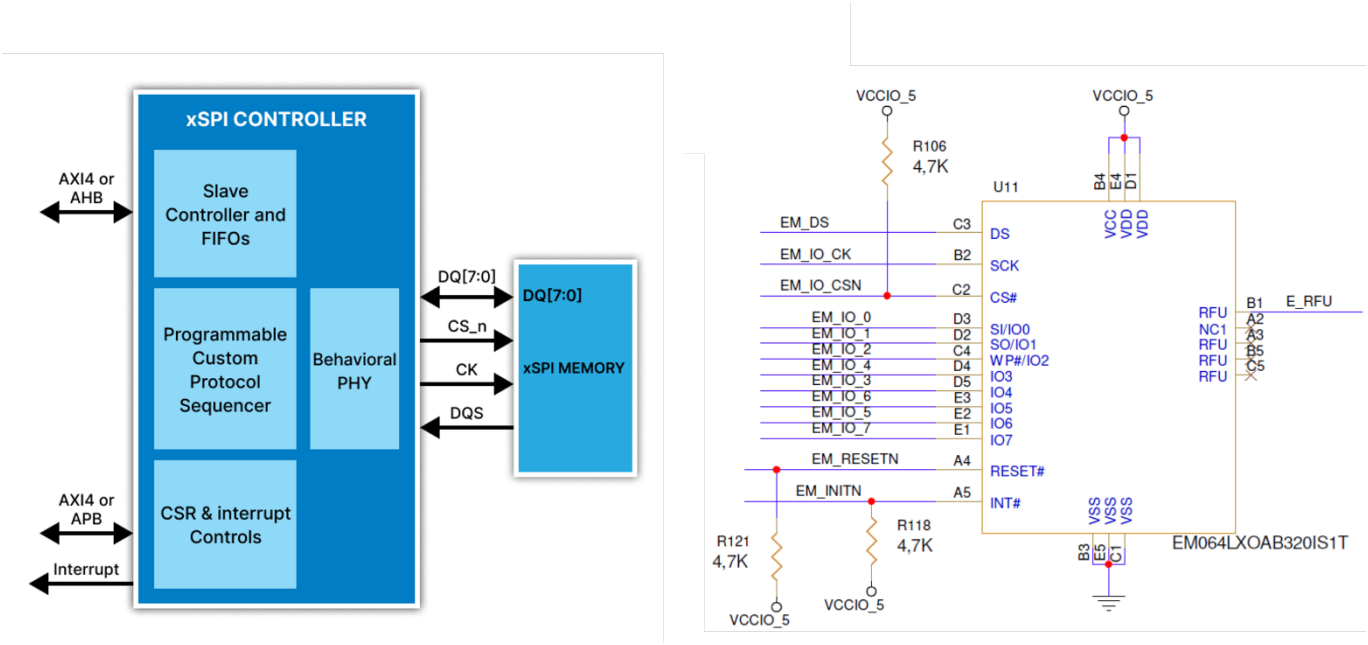


Figure 2. MRAM Octal SPI Interface Connection Diagram

Conclusion

PLCs are critical in industrial automation, offering precise control and execution for industrial process requirements. Understanding PLC memory needs is essential for any designer in the industrial automation field. By utilizing Everspin Technologies MRAM's persistence, low latency, and high endurance writing at cost-effective capacities, engineers can ensure efficient and reliable operation of PLC systems. Everspin Technologies MRAM adoption in PLC systems requiring continuous data-logging of parametric and environmental information as well as the ability to store, execute, and rapidly run code/software updates provides system designers a highly versatile memory to meet the needs of increasingly intelligent and adaptive systems.

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