

## Hexadecimal

Hexadecimal is another system used in PLCs. The hexadecimal system has the following characteristics:

16 digits	0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F
Base	16
Weights	Powers of base 16 (1, 16, 256, 4096 ...)

The ten digits of the decimal system are used for the first ten digits of the hexadecimal system. The first six letters of the alphabet are used for the remaining six digits.

A = 10	D = 13
B = 11	E = 14
C = 12	F = 15

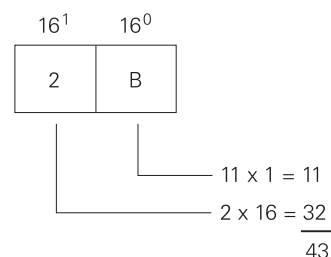
The hexadecimal system is used in PLCs because it allows the status of a large number of binary bits to be represented in a small space such as on a computer screen or programming device display. Each hexadecimal digit represents the exact status of four binary bits. To convert a decimal number to a hexadecimal number the decimal number is divided by the base of 16. To convert decimal 28, for example, to hexadecimal:

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Decimal 28 divided by 16 is 1 with a remainder of 12. Twelve is equivalent to C in hexadecimal. The hexadecimal equivalent of decimal 28 is 1C.

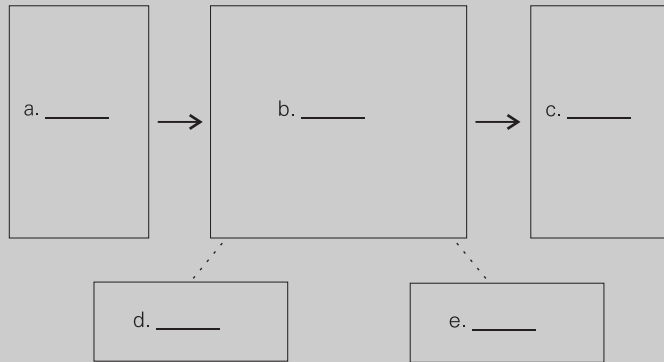
The decimal value of a hexadecimal number is obtained by multiplying the individual hexadecimal digits by the base 16 weight and then adding the results. In the following example the hexadecimal number 2B is converted to its decimal equivalent of 43.

$$\begin{aligned}16^0 &= 1 \\16^1 &= 16 \\B &= 11\end{aligned}$$



## Review 1

1. Identify the following:



2. The binary number system has a base \_\_\_\_\_ .

3. The hexadecimal number system has a base \_\_\_\_\_ .

4. Convert a decimal 10 to the following:

Binary \_\_\_\_\_

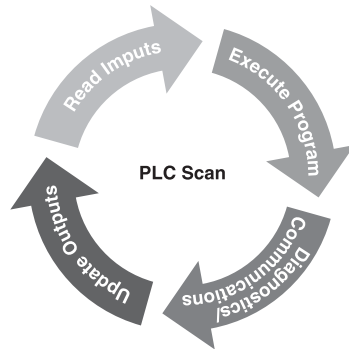
BCD \_\_\_\_\_

Hexadecimal \_\_\_\_\_

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## PLC Scan

The PLC program is executed as part of a repetitive process referred to as a scan. A PLC scan starts with the CPU reading the status of inputs. The application program is executed using the status of the inputs. Once the program is completed, the CPU performs internal diagnostics and communication tasks. The scan cycle ends by updating the outputs, then starts over. The cycle time depends on the size of the program, the number of I/Os, and the amount of communication required.



## Software

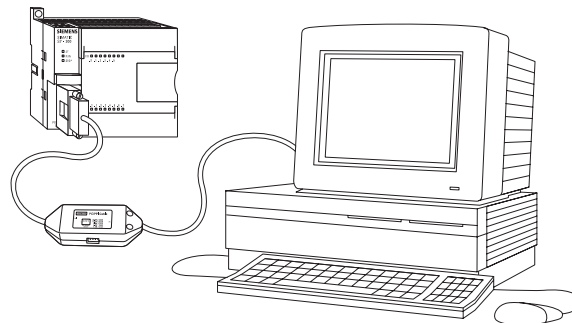
Software is any information in a form that a computer or PLC can use. Software includes the instructions or programs that direct hardware.

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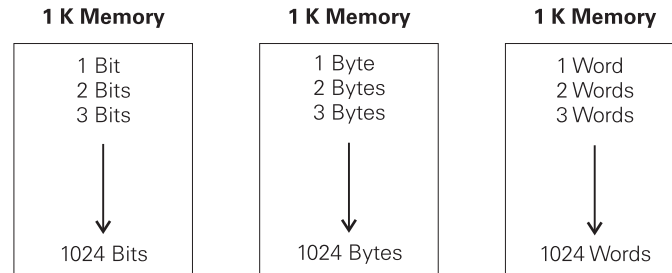
## Hardware

Hardware is the actual equipment. The PLC, the programming device, and the connecting cable are examples of hardware.



## Memory Size

Kilo, abbreviated K, normally refers to 1000 units. When talking about computer or PLC memory, however, 1K means 1024. This is because of the binary number system ( $2^{10}=1024$ ). This can be 1024 bits, 1024 bytes, or 1024 words, depending on memory type.



## RAM

Random Access Memory (RAM) is memory where data can be directly accessed at any address. Data can be written to and read from RAM. RAM is used as a temporary storage area. RAM is volatile, meaning that the data stored in RAM will be lost if power is lost. A battery backup is required to avoid losing data in the event of a power loss.

## ROM

Read Only Memory (ROM) is a type of memory that data can be read from but not written to. This type of memory is used to protect data or programs from accidental erasure. ROM memory is nonvolatile. This means a user program will not lose data during a loss of electrical power. ROM is normally used to store the programs that define the capabilities of the PLC.

## EPROM

Erasable Programmable Read Only Memory (EPROM) provides some level of security against unauthorized or unwanted changes in a program. EPROMs are designed so that data stored in them can be read, but not easily altered. Changing EPROM data requires a special effort. UVEPROMs (ultraviolet erasable programmable read only memory) can only be erased with an ultraviolet light. EEPROM (electronically erasable programmable read only memory), can only be erased electronically.

## Firmware

Firmware is user or application specific software burned into EPROM and delivered as part of the hardware. Firmware gives the PLC its basic functionality.

