What is meant by:

Bit :

Bit is the smallest unit of storage. A bit stores just a “0” or “1”. The Bit is suitable to represents the lamp’s state (dark, shining). The Bit is suitable to represents the push-button states (presses, released). The Bit is suitable to represents the selector switch (ON,OFF).

Byte :

Byte is a group of 8 bits.

When all its eight bits take their “0” value

($2^7*0 + 2^6*0 +2^5*0\ 2^4*0 +2^3*0 +2^2*0 +2^1*0 +2^0*0$) , the decimal equivalent of the Byte is “0”.

When all its eight bits take their “1” value

($2^7*1 + 2^6*1 +2^5*1\ 2^4*1 +2^3*1 +2^2*1 +2^1*1 +2^0*1$) , the decimal equivalent of the Byte is “255” and this equals to 2^8-1 (where 8 refers to the fact that the Byte consists of 8 Bits).

Word :

Word is a group of 16 Bits (two Bytes).

When all its sixteen bits take their “0” value

($2^{15}*0 + 2^{14}*0 + 2^{13}*0 +2^{12}*0 +2^{11}*0 +2^{10}*0 +2^9*0 + 2^8*0 + 2^7*0 + 2^6*0 +2^5*0 +2^4*0 +2^3*0 +2^2*0 +2^1*0 +2^0*0$)

, the decimal equivalent of the Word is “0”.

When all its sixteen bits take their “1” value

($2^{15}*1 + 2^{14}*1 + 2^{13}*1 +2^{12}*1 +2^{11}*1 +2^{10}*1 +2^9*1 + 2^8*1 + 2^7*1 + 2^6*1 +2^5*1 +2^4*1 +2^3*1 +2^2*1 +2^1*1 +2^0*1$)

, the decimal equivalent of the Word is “65535” and this equals 2^{16}-1 (where 16 refers to the fact that the Word consists of 16 Bits) .

Double Word :

Double Word is a group of 32 Bits (2 words or 4 bytes).

When all its thirty two bits take their “0” value

($2^{31}*0$ + …………….. $+2^{11}*0$ $+2^{10}*0$ $+2^{9}*0$ + $2^{8}*0$ + $2^{7}*0$ + $2^{6}*0$ $+2^{5}*0$ $+2^{4}*0$ $+2^{3}*0$ $+2^{2}*0$ $+2^{1}*0$ $+2^{0}*0$)

, the decimal equivalent of the Double Word is “0”.

When all its thirty two bits take their “1” value

($2^{31}*1$ + ……………. $+2^{11}*1$ $+2^{10}*1$ $+2^{9}*1$ + $2^{8}*1$ + $2^{7}*1$ + $2^{6}*1$ $+2^{5}*1$ $+2^{4}*1$ $+2^{3}*1$ $+2^{2}*1$ $+2^{1}*1$ $+2^{0}*1$)

, the decimal equivalent of the Double Word is “4 294 967 295” and this equals $2^{32}-1$ (where 32 refers to the fact that Double Word consists of 32 Bits) .

Long Word :

Long Word is a group of 64 Bits (4 words or 8 bytes).

When all its sixty four bits take their “0” value

($2^{63}*0$ + …………….. $+2^{11}*0$ $+2^{10}*0$ $+2^{9}*0$ + $2^{8}*0$ + $2^{7}*0$ + $2^{6}*0$ $+2^{5}*0$ $+2^{4}*0$ $+2^{3}*0$ $+2^{2}*0$ $+2^{1}*0$ $+2^{0}*0$)

, the decimal equivalent of the Long Word is “0”.

When all its sixty four bits take their “1” value

($2^{63}*1$ + ……………. $+2^{11}*1$ $+2^{10}*1$ $+2^{9}*1$ + $2^{8}*1$ + $2^{7}*1$ + $2^{6}*1$ $+2^{5}*1$ $+2^{4}*1$ $+2^{3}*1$ $+2^{2}*1$ $+2^{1}*1$ $+2^{0}*1$)

, the decimal equivalent of the Long Word is “9223 3720 3685 4775 807” and this equals $2^{64}-1$ (where 64 refers to the fact that Long Word consists of 64 Bits) .

Integer :

Integer is a whole number (not fractional number) that can be positive, negative, or zero.

The following numbers are integer type numbers :

0,1,1000,1959, -2000, -16000, 16000, etc.

In PLC and in computers in general, Integer number is represented by 16 bits (one Word or two Bytes), the most significant bit (the bit with weight 2^{15}) is used for the number's sign (1means negative number and 0 means positive number) whereas the remaining 15 bits are used for the number's magnitude. Because of this distribution , the Integer number takes values from -32768 through 0 to 32767 .

Why the maximum value of integer number is 32767?

Answer:

As mentioned above, the number of bits allocated for the magnitude in integer type is 15 bits and this reaches its maximum value when all the bits take their "1" value

$(2^{14}*1 + 2^{13}*1 +2^{12}*1 +2^{11}*1 +2^{10}*1 +2^{9}*1 + 2^{8}*1 + 2^{7}*1 + 2^{6}*1 +2^{5}*1 +2^{4}*1 +2^{3}*1 +2^{2}*1 +2^{1}*1 +2^{0}*1)$
$=2^{15}-1=32767$

Why the minimum value of integer number is32768?

The negative number is represented by two's complement. The two's complement is calculated by first inverting the bits of the number (0 is changed into 1 and 1 is changed to 0) and then add one to the result.

Example :

The two's complement of the binary number "101" is calculated

As follow:

Step 1: invert the number bits "101" after inversion became "010"

Step 2: add one to the inverted result : "010" +1="011"

In case of integer type as stated above only 15 bits are allocated for the magnitude of the number. So when all the bits are "0" the two's complement is calculated as :

Step 1 : "000 0000 0000 0000 " is inverted into "111 1111 1111 1111 " and this equal to 32767.

Step2: adds 1 to step 1 so the magnitude became 32767 +1=32768=2^{15}.

And this in case of negative number means -32768.

when all the bits are "1" the two's complement is calculated as :

Step 1 : "111 1111 1111 1111 " is inverted into "000 0000 0000 0000 " and this equal to 0.

Step2: adds 1 to step 1 so the magnitude became 0 +1=1.

And this in case of negative number means -1.

Double Integer :

In PLC and in computers , Double Integer number is represented by 32 bits (two Words or 4 Bytes), the most significant bit (the bit with weight 2^{31}) is used for the number's sign (1means negative number and 0 means positive number) whereas the remaining 31 bits are used for the number's magnitude. Because of this distribution , the Double Integer number takes values from -2147483648 ($=-2^{31}$) through 0 to 2147483647 ($=2^{31}-1$).

Long Integer :

In PLC and in computers , Long Integer number is represented by 64 (4 Words or 8 Bytes) bits, the most significant bit (the bit with weight 2^{63}) is used for the number's sign whereas the remaining 63 bits are used for the number's magnitude. Because of this distribution, the Long Integer number takes values from -2^{63} through 0 to 2^{63} -1.

Unsigned Integer :

In PLC and in computers , Unsigned Integer number is represented by 16 bits (one Word). It differs from the Integer by the maximum and the minimum values because the Integer type uses 15 bits for the magnitude and one bit for the sign where as the Unsigned Integer takes only positive values and so the whole number of bits (16 bits) are used for the number representation . Its minimum value is 0 and its maximum value is 65535 (2^{16}-1).

Unsigned Double Integer :

In PLC and in computers , Unsigned Double Integer number is represented by 32 bits (two Word). It differs from the Double Integer by the maximum and the minimum values because the Double Integer type uses 31 bits for the magnitude and one bit for the sign where as the Unsigned Doble Integer takes only positive values and so the whole number of bits (32 bits) are used for the number representation . Its minimum value is 0 and its maximum value is

4294 9672 95 (2^{32}-1).

Unsigned Long Integer :

In PLC and in computers , Unsigned Long Integer number is represented by 64 bits (4 Words). It differs from the Long Integer by the maximum and the minimum values because the Long Integer type uses 63 bits for the magnitude and one bit for the sign where as the Unsigned Doble Integer takes only positive values and so the whole number of bits (64 bits) are used for the number representation . Its minimum value is 0 and its maximum value is

1844 6744 o737 0955 1615 (2^{64}-1).