**PLC's Contacts & Coils Instructions**

In PLC programming, contacts and coils instructions play the same roles of the independent and dependent variables of Boolean expression assignment statements A O B = C in which A and B are the independent variables , O is the logic function, and C is the dependent variable ( mapping result). The contact instructions { | | , |/| , |P| , |N|} form the independent variables set whereas the coil instructions { ( ), ( / ), ( S ), ( R ), ( P ), ( N ) } take the position of the dependent ones . Each of aforementioned PLC instructions has its own unique applications. The following will details the meaning and applications of these instructions :

## 2.1 Normally Open Contact Instruction ( | | )

This contact functions as if it were a normally open contact of a magnetic contactor. When being activated, it bridges the rung points connected to its left and right sides. Each contact has its own label and is linked to bit in the input, output, or memory process register . The state of the contact reflects the state of its driving bit. When the driving bit is "0" the contact behaves as an open circuit and behaves as a closed or short circuit when the driving bit is "1". The way these contacts are connected is very important. The serial connection gives AND logic gate's equivalent. The parallel gives the equivalent of the OR logic gate.

Fig, 2.1 shows how to construct 3-input AND logic gate using normally open contact instruction.

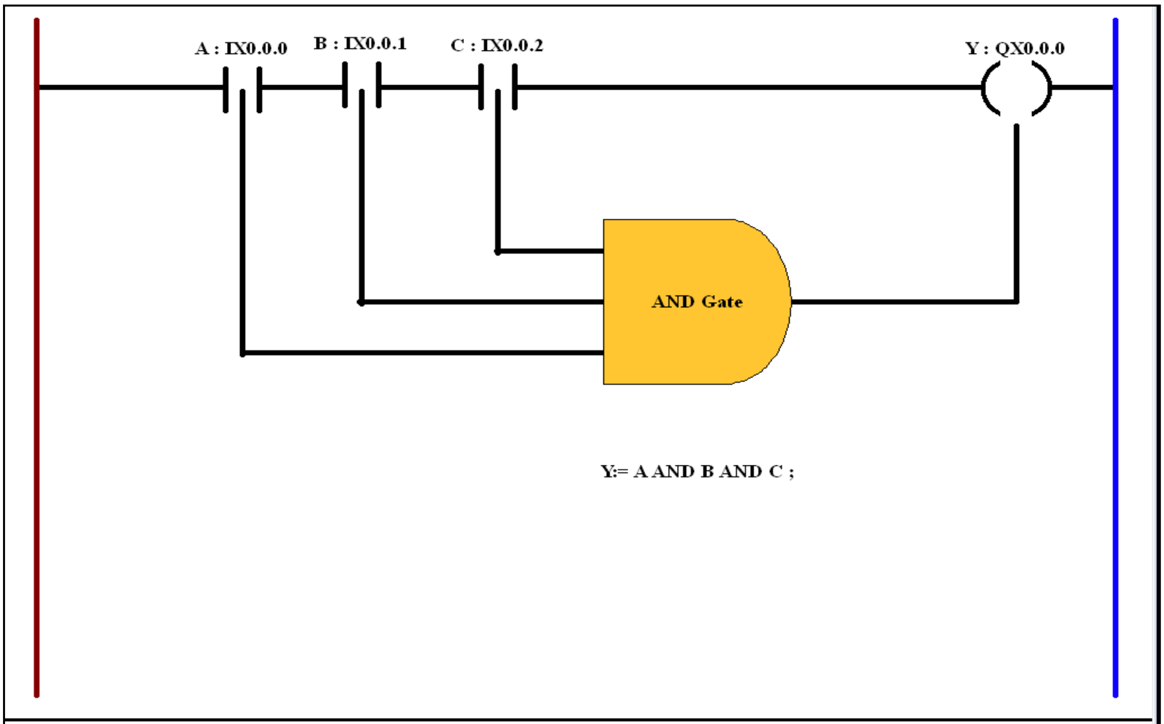


Figure 2.1 : 3-input AND Gate

Fig. 2.2 represents the Construction of 3-input OR gate using the normally open contact Instruction.

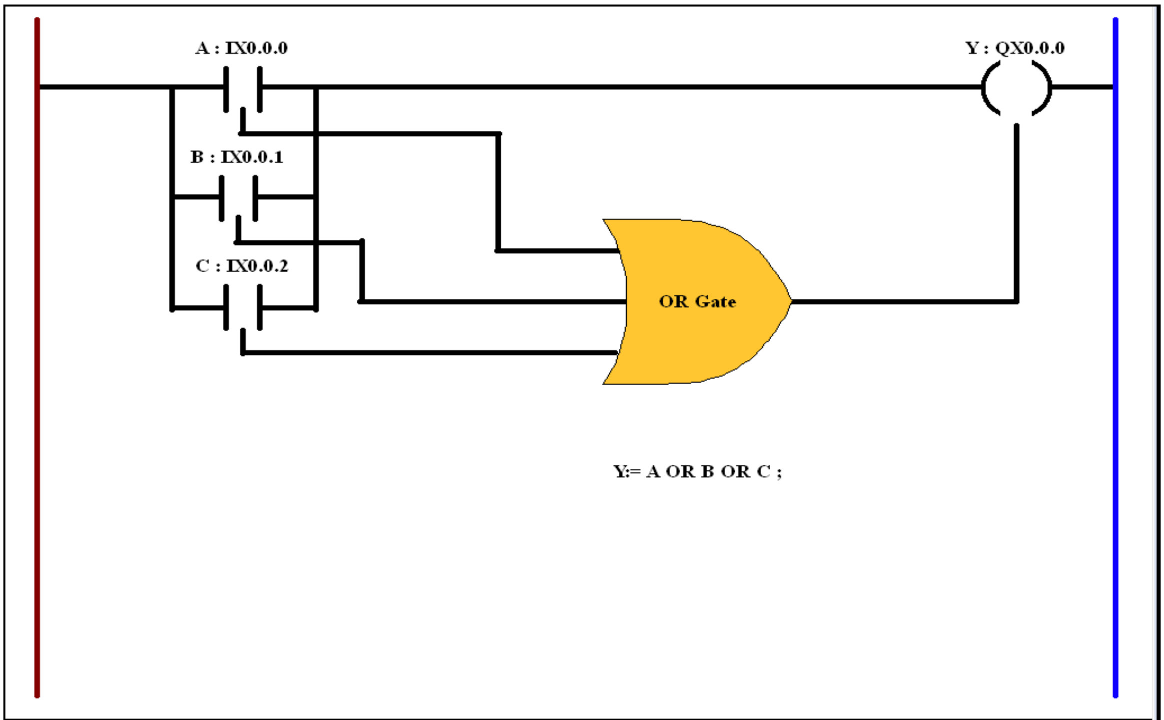


Figure 2.2 : 3-input OR Gate

**2.2 Normally Closed Contact Instruction ( | / | )**

The normally closed contact instruction takes the role of the normally closed contact of magnetic relay. As its instance when being activated, disconnects the rung points connected to its left and rights sides. The state of the contact reflects the negated state of its driving bit. When the driving bit is "1" the contact behaves as an open circuit and behaves as a closed circuit when the driving bit is "0". The way these contacts are connected is also important. The serial connection gives NOR logic gate's equivalent and the parallel one gives the NAND logic gate equivalent.

Fig,2.3 displays the construction of 3-input NOR gate using the normally closed contact.

Fig.2.4 shows how to constructs 3- input NAND logic gate using normally closed contact Instructions.

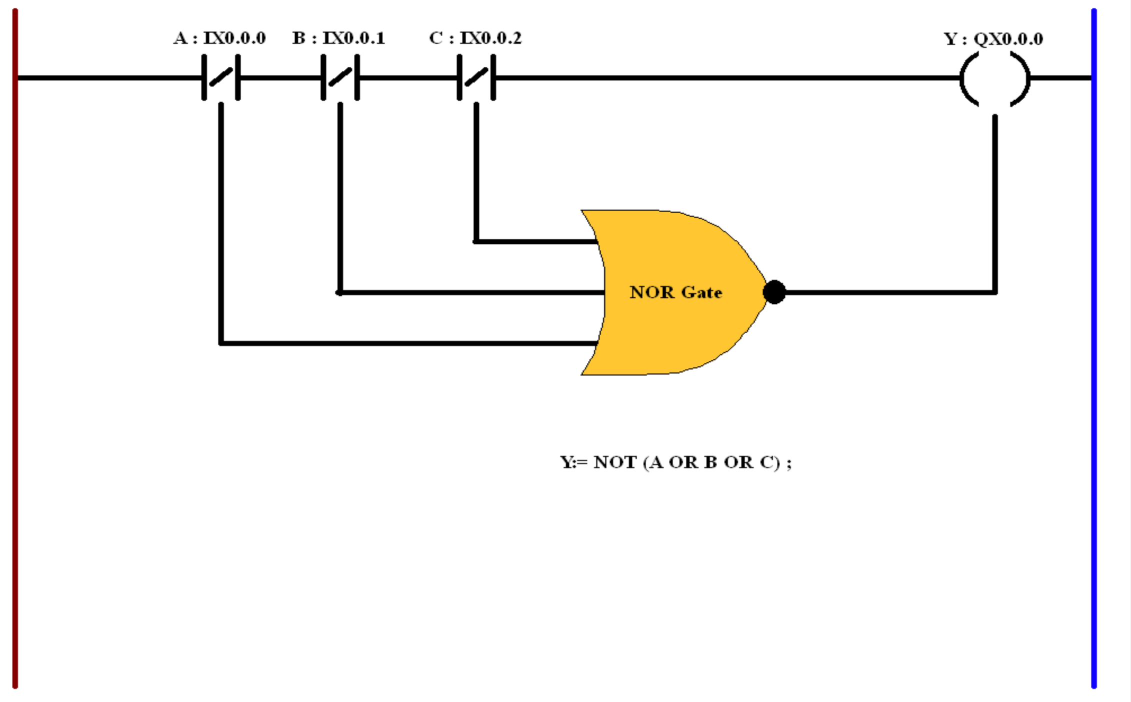


Figure 2.3 : 3-input NOR Gate

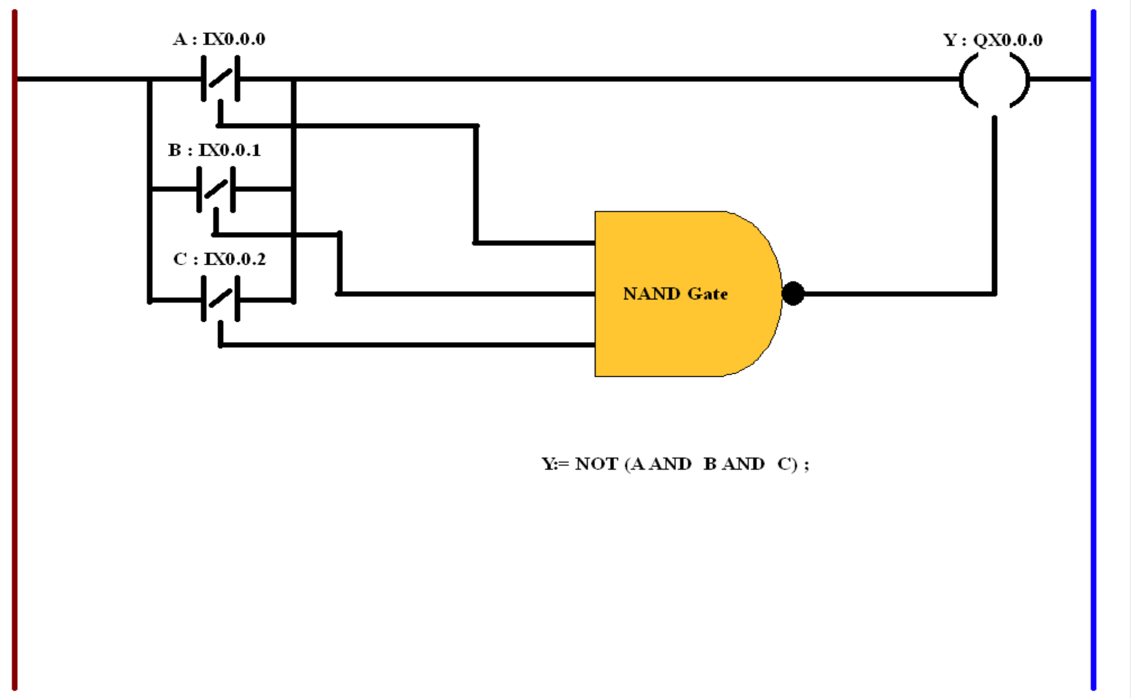


Figure 2.4 : 3-input NAND Gate

## 2.3 Positive Transition Sensing Contact Instruction ( | P | )

This one _scan _ON instruction functions as if it were a positive triggered monostable vibrator. When its driving bit changes from zero ( its valve at the previous scan ) to one ( at the current scan ), its right side takes logic one value only during the current scan and return back to zero at the next scan. Figure 2.5 shows the behavior of such instruction .

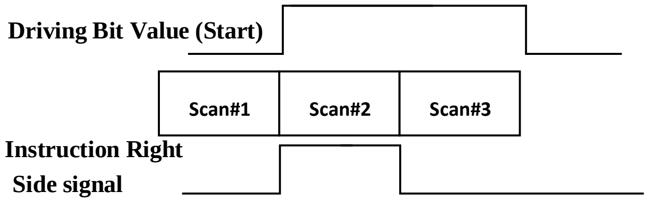


Figure 2.5: Positive transition sensing contact behavior

Fig 2.6 states how to use this instruction in constructing rising edge T flip-flop.

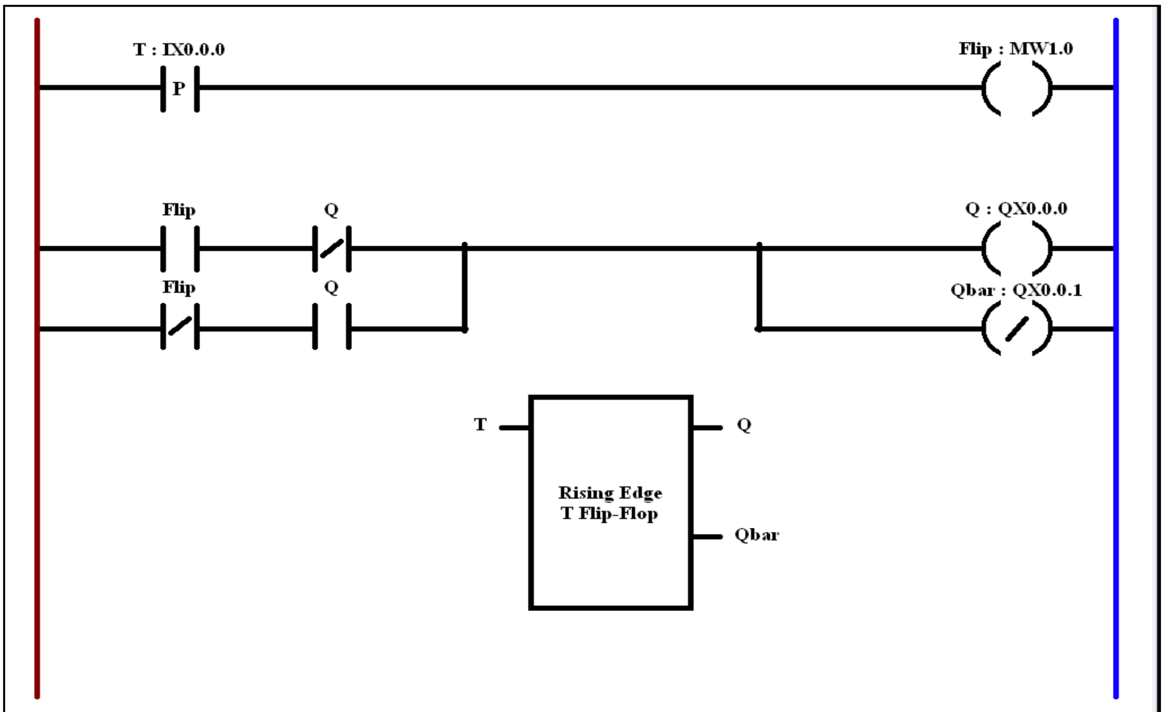


Figure 2.6 : Rising edge T flip-flop

## 2.4 Negative Transition Sensing Contact Instruction ( | N | )

This one is identical to its predecessor except that the temporary logic one state takes place at the transition of its logic value from logic one ( its value at the previous state) to logic zero ( at the current scan) and then return to zero again ( at the next scan. Figure 2.7 shows the behavior of such instruction .

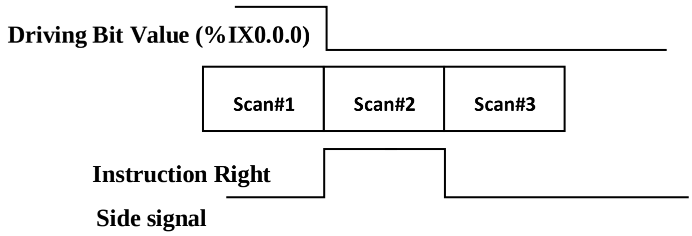


Figure 2.7: Negative transition sensing contact

Fig. 2.8 illustrates how this instruction can be used to construct falling edge T flip-flop.

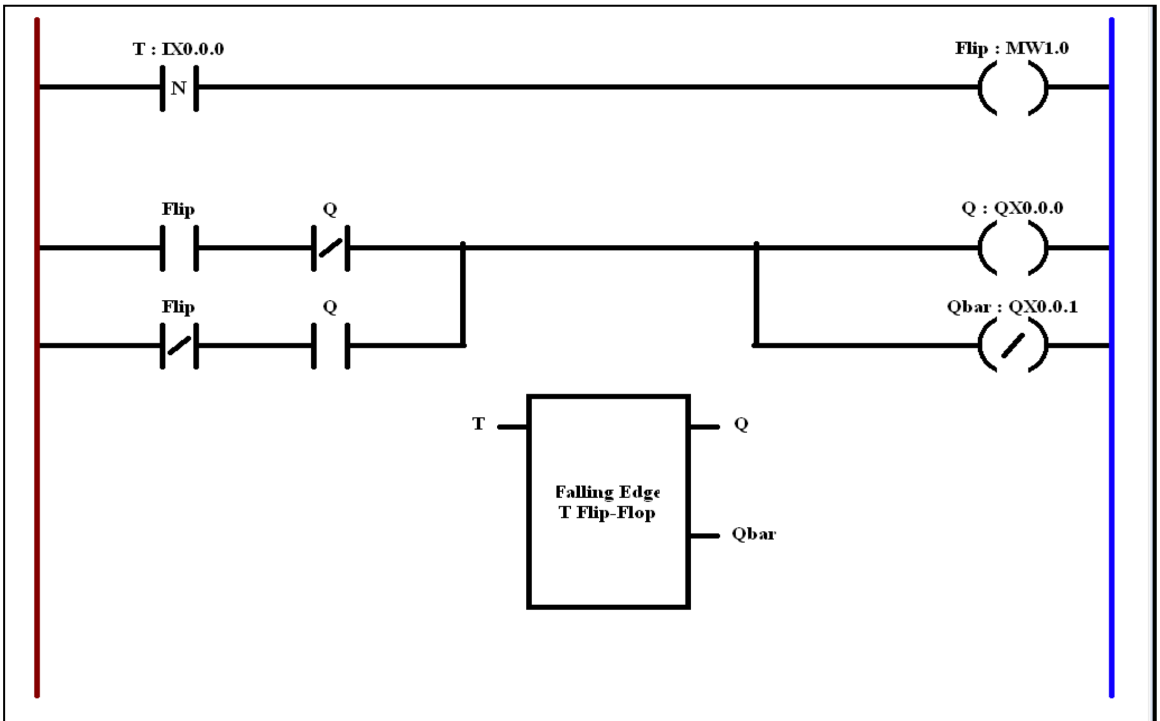


Figure 2.8 : Falling edge T flip-flop

## 2.5 Coil Instruction ( ( ) )

This coil instruction behaves the same way the magnetic contactor's coil behaves. Its activation and deactivation depends upon its left side rung logic value. Logic one means an active state and this means writing "1" in its corresponding bit location in the process-image register. Logic zero resets it corresponding bit. In other words, one can say that this instruction is the dependent logic variable in a logic expression ( Ex :D= ( A AND B ) OR C.

Fig. 2.9 shows this coil instruction represents the dependent variable " D" in the logic expression " D = ( A AND B ) OR C ".

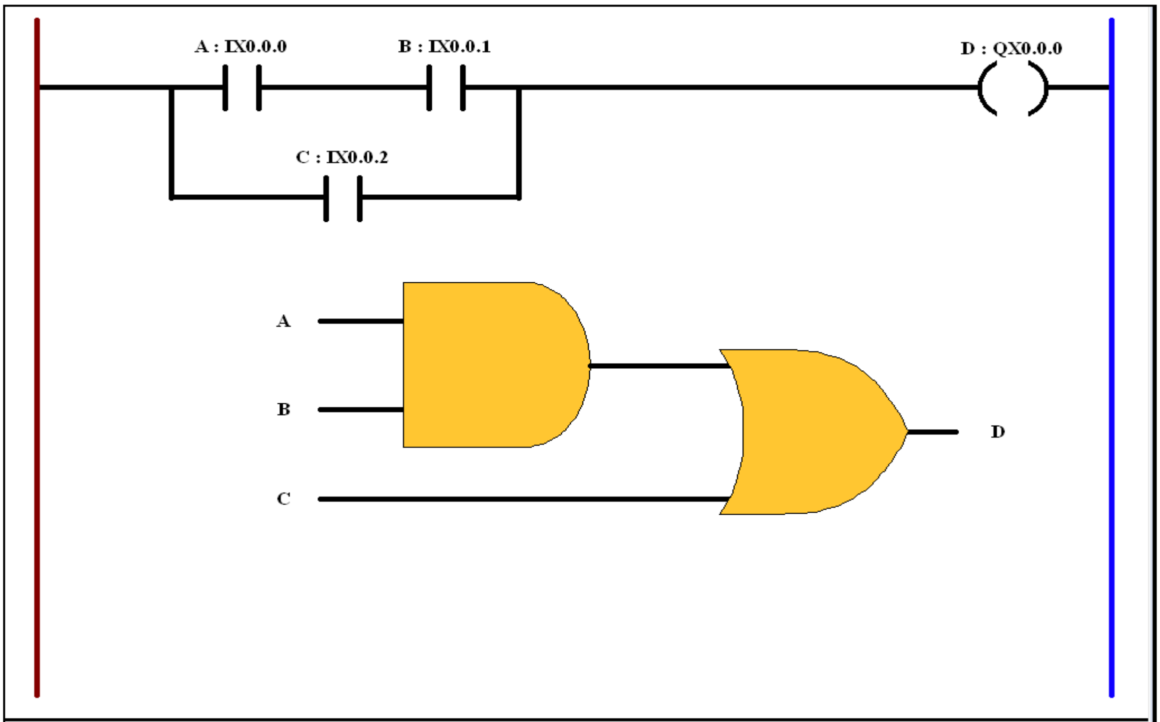


Figure 2.9 : D = ( A AND B ) OR C;

## 2.6 Negated Coil Instruction ( ( / ) )

The negated coil instruction can be considered as coil instruction followed by logic NOT gate . It does the reverse of the normal coil instruction. When the logic value of its left side rung equals "1" , it writes "0" in its corresponding bit location in the process-image register and does the reverse when its left side rung jumps to "1".

Fig. 2.10 displays the realization of DeMorgan's Theorem 1 ( The complements of a product of variable is equal to the sum of the complements of the variables) using this negated coil instruction.

Fig. 2.11 displays the realization of DeMorgan's Theorem 2 ( The complements of sum of variable is equal to the product of the complements of the variables) also making use of this negated coil instruction.

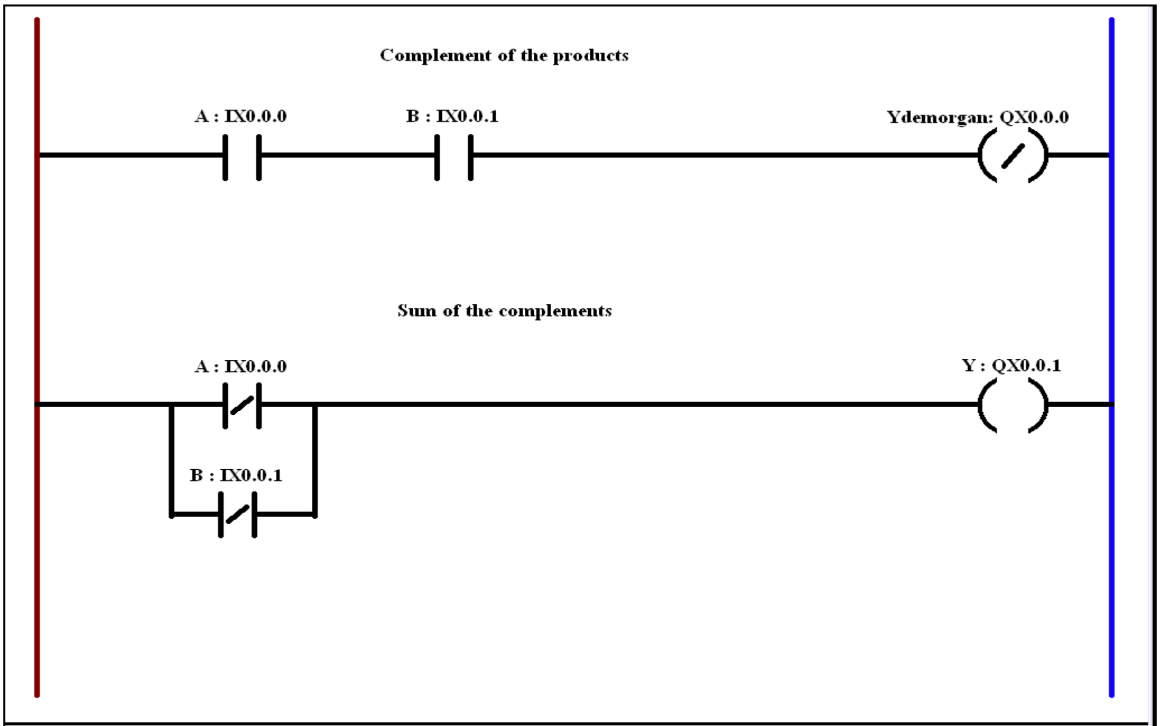


Figure 2.10: DeMorgan's Theorem 1

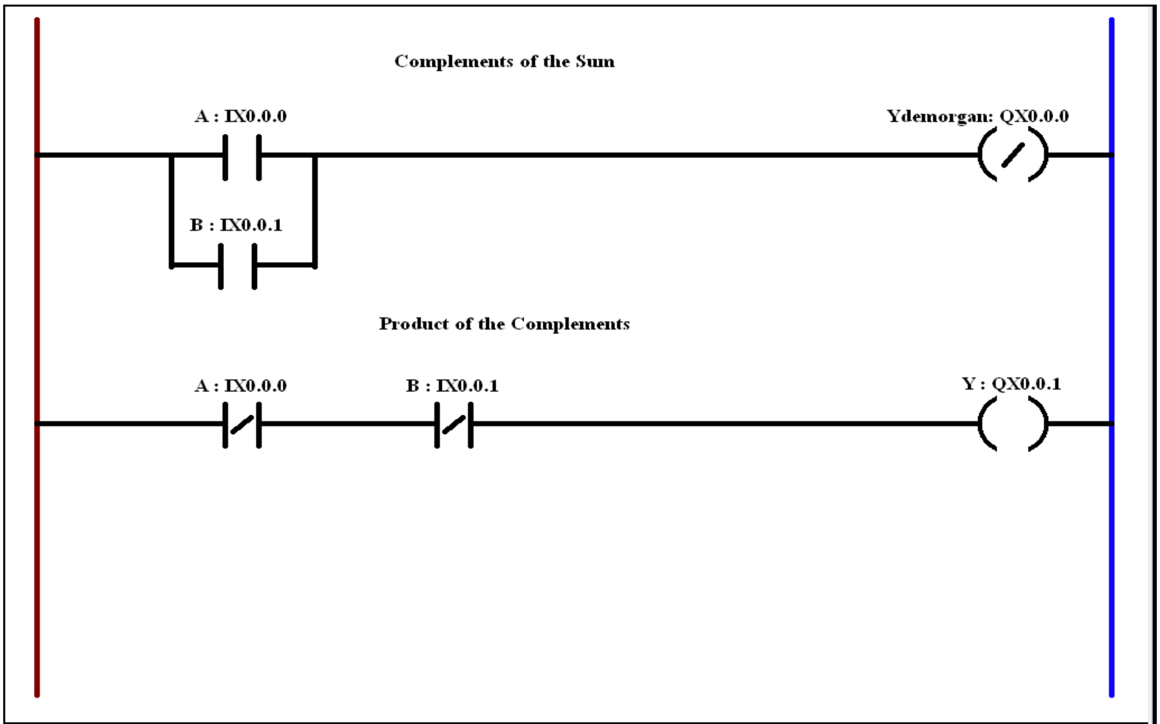


Figure 2.11: DeMorgan's Theorem 2

## 2.7 SET & RESET Coil Instructions ( ( S ) & ( R ) )

These two coils instructions control the same bit in the process-image register. The SET coil instruction sets the bit ( write logic "1" to the bit) when its left side rung toggle to logic "1" and remain so what over the value of its left side rung is. The RESET coil instruction reset the bit(write logic "0" to the bit) set by SET instruction when its left side rung toggle to logic "1" and remain so what over the value of its left side rung is. From the point of view of digital logic, these two coil instructions play the same roles of the "S" and "R" inputs of the well-known SR flip-flop.

Fig. 2.12 uses the SET and RESET coil instruction in building first in priority circuit.

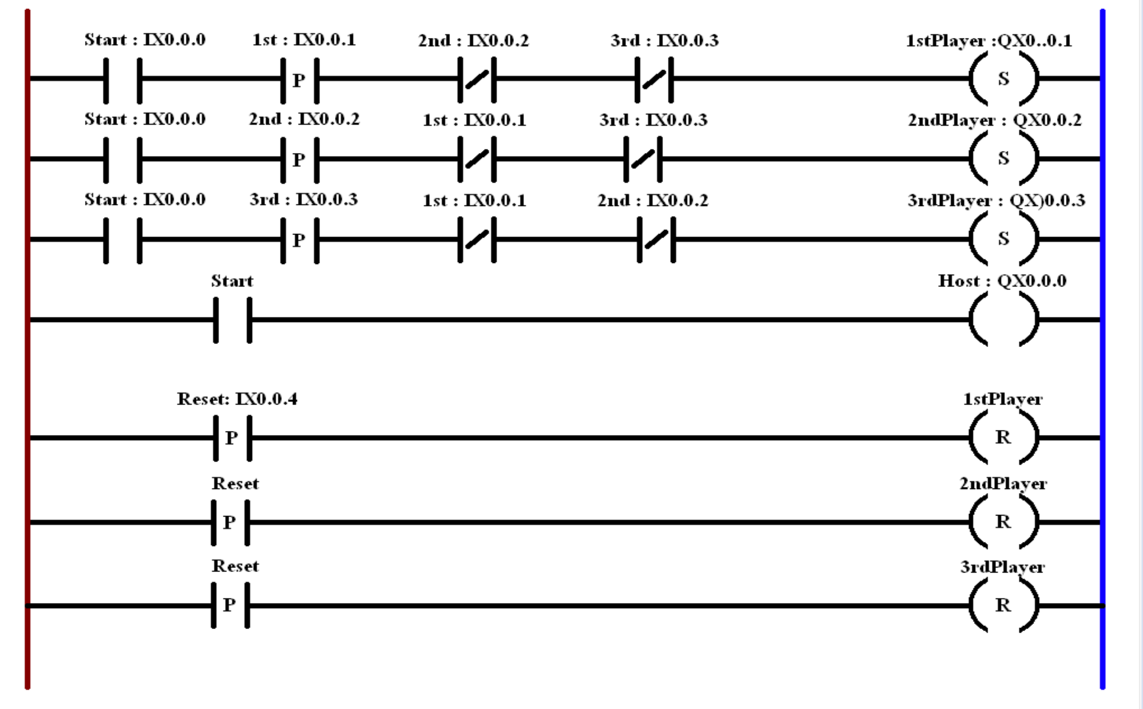


Figure 2.12: First IN Priority Circuit

## 2.8 Positive Transition Sensing Coil Instructions ( ( P ))

The positive transition sensing coil instruction can be considered as coil instruction preceded by positive transition sensing contact. When its left side rung logic value changes from zero ( rung valve at the previous scan ) to one ( at the current scan ) this coil instruction forces its corresponding bit in the process image register to take logic "1" only during this current scan. Figure 2.13 shows the behavior of such instruction .

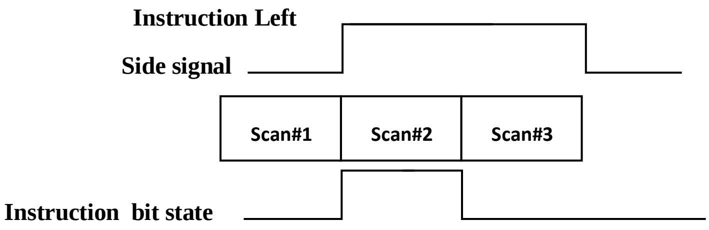


Figure 2.13: Positive transition sensing coil behavior

Fig. 2.14 uses positive transition sensing coil instruction to build positive triggered JK flip flop

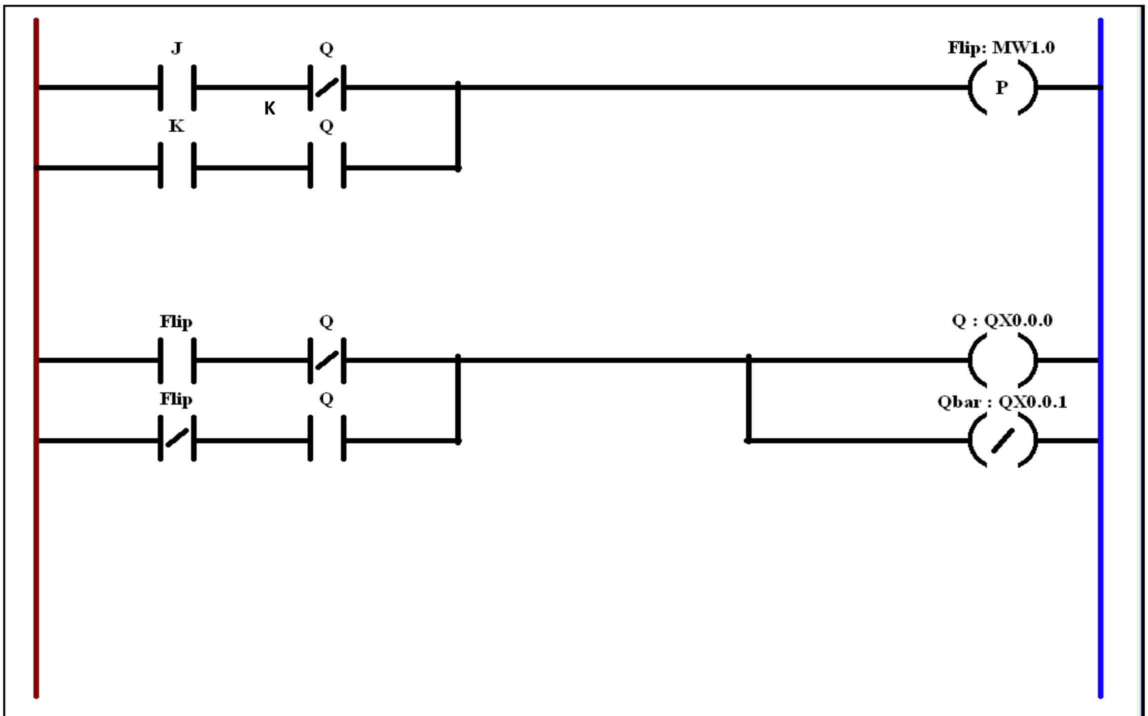


Figure 2.13: Positive triggered JK Flip-Flop

## 2.9 Negative Transition Sensing Coil Instructions ( ( N ))

The negative transition sensing coil instruction does the reverse of its counterpart , the positive transition sensing coil instruction. When its left side rung logic value changes from one ( rung valve at the previous scan ) to zero ( at the current scan ) this coil instruction forces its corresponding bit in the process image register to take logic "1" only during the current scan.

Figure 2.14 shows its usage in constructing negative triggered JK Flip-Flop.

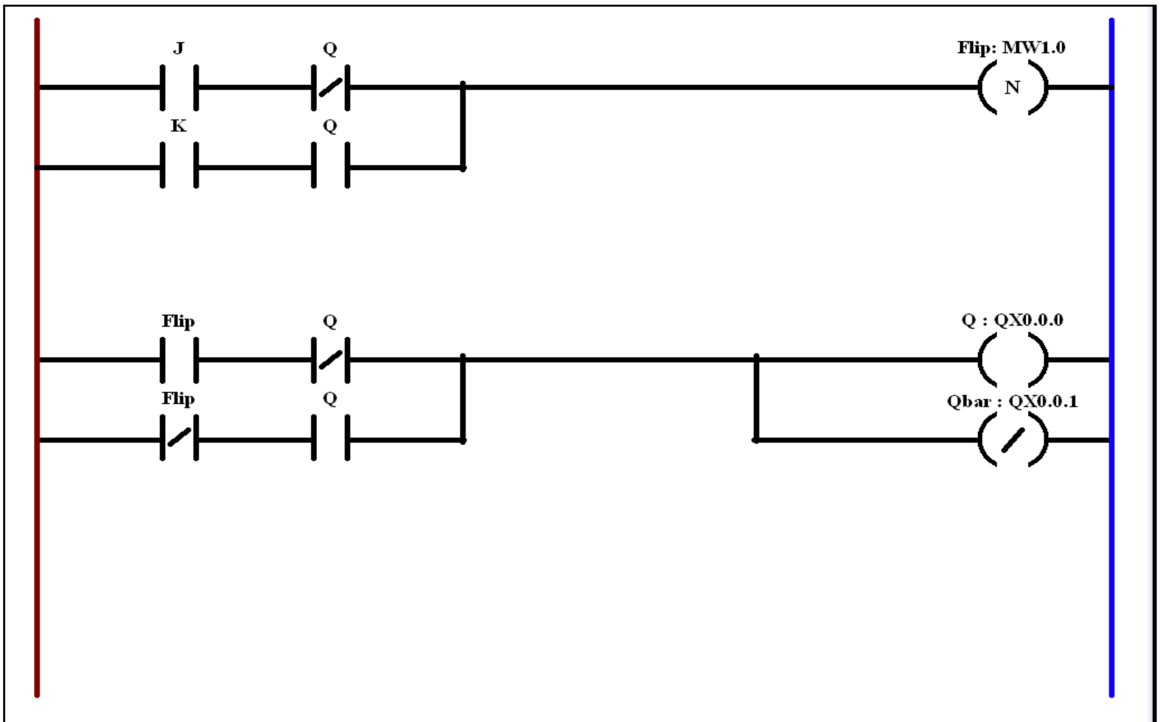


Figure 2.14: Negative triggered JK Flip-Flop