

# **Use amplification for SR with sensor**

## **Preface**

Science technology is our footstones for human society, and technology is not only necessary every moment but also it is match up with society development steps. Sensor technology is developing speedily, that is important flag for science technology development nowadays. Our product SR and SR belong to automatic controller product, which can receive all signal from sensor and can perform many operation. If the intelligent controller is made as our brain, electric sensor is our facial features (sight, nose, taste, hearing and touch). Sensor output is distributed current type and voltage type, if it is the voltage output, that can directly linked with our product; if it is the current output, that can first need to circuit transformation and then linked with our product. The below part is introduced using plan between sensor and our product in detail.

## **Key word**

Sensor      Intelligent controller PLC      SR

## **Principle analysis**

Basically physical variation should change into resistance, current and voltage etc., and its output is in the form of voltage through translation circuit, finally the data is processed from the control unit port to PC to perform all kinds of automatic control application. The circuit flow diagram is as bellow:

Inductive variation→Translation circuit→Voltage output→Control unit port

The main function explanation for the approach switch:

### **1. Check distance**

Check start-stop and route of travel for elevator; check vehicle position and prevent crash; check the set position and limited position for work machine; check a stop position for solid of revolution and on and off position for valve; check a move position for cylinder piston.

### **2. Measurement control**

Plaque measurement control; automatic select and distinguish metal length; check object height when loading or unloading; check the length, width, height and volume for goods

### **3. Check our goods exist**

Check the package box exist in product line or product parts

#### 4. Rotation speed and speed control

Control conveyer speed; control rotation speed of rotary machine; control a rotation speed and amount with pulse generator

#### 5. Account and control

Check product number in production line; count the rotation amount for high speed rotating shaft; count part numbers

#### 6. Check exception

Check cap exist; judge product pass or not pass; check metal part exist in packing box; distribute metal or nonmetal parts; check product flag exist; crane alarm for dangerous zone; automatic on and off for safe elevator

#### 7. Calculation control

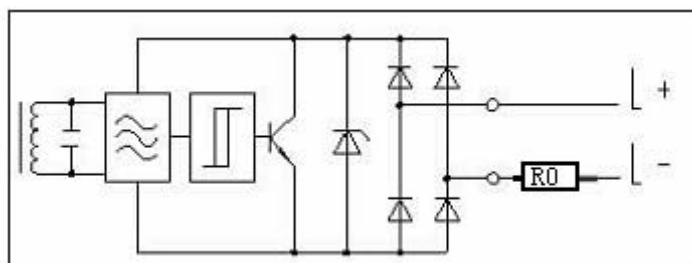
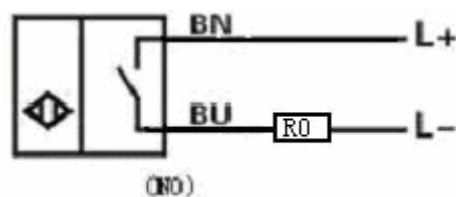
Automatic calculation for product or part; check pointer range for meter; check float height and flow; check iron float in stainless barrel; upper or lower limit control for meter range; flow control and level plane control

#### 8. Distinguish object

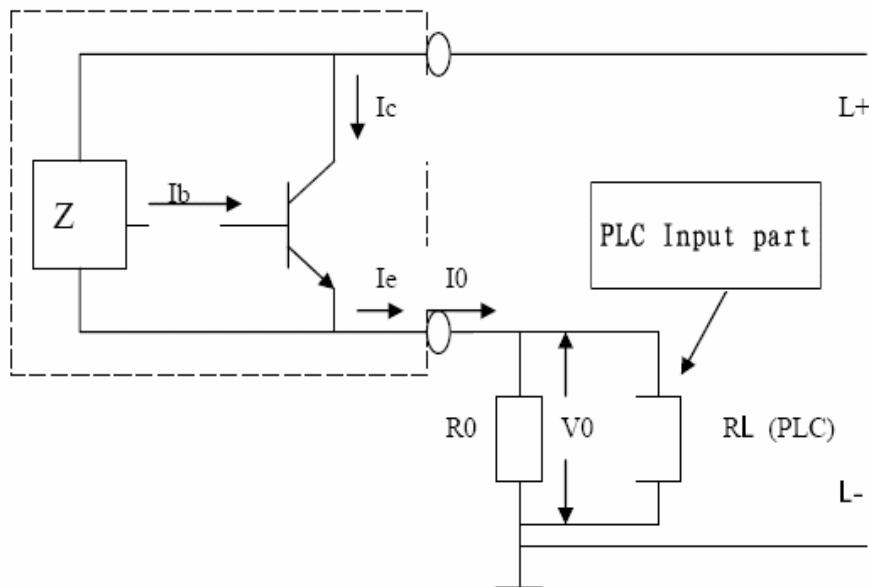
Distinguish yes or no by object code

Example 1: Inductance double line DC approach switch with SR

Structure chart is as bellows:



Equipment circuit diagram:



Analyze resistance  $R_0$  value and connection sensor with PLC:

In the equipment circuit diagram, virtual frame represents the approach switch;  $Z$  represents inductive component of approach switch;  $R_0$  represents the additional resistance;  $RL$  represents the equipment resistance of load PLC;  $I_b$  represents the output current of approach switch in the normal working and that is the basic current of triode;  $I_c$  represents collector current of triode;  $I_e$  represents the emitter current of triode;  $I_0$  represents output current of the approach switch; the voltage between  $L+$  and  $L-$  is used for supplying the drive voltage of the inductive component and triode.  $\perp$  symbol represents the common reference electric potential, not the real earth. Like that, every electric potential in this circuit is potential difference with this port. (i.e. voltage)

When the approach switch nears to metal, inductive component  $Z$  gives a current  $I_b$  into the triode base to drive its work, and  $I_e$  flows into resistance  $R_0$  which would have potential difference  $V_0$ , so PLC with parallel  $R_0$  has voltage input signal  $V_0$ . We give an example to analyze that  $R_0$  value has impact extent to the whole circuit.

Technical parameter for approach switch: Input Voltage DC10V-30V, Output Current  $I_0=100mA$ ;

PLC Technical parameter: Type AF-10MR-D, Input Voltage 12V-24V, Input Resistance  $RL=842\Omega$ , Voltage range for 0 input signal is DC0-5V, Voltage range for 1 input signal is DC12-24V.

If the approach switch is off status, leakage current will be set MAX 0.8mA and max voltage for 0 input signal will be 5V.

Therefore;

$$R_0 = U/I'$$

$R_0 = 5V / 0.8mA = 6.25 K\Omega$ , if  $R_0$  is more than  $6.25 K\Omega$  that will cause error operation, so that resistance  $R_0$  is max  $6.25 K\Omega$ .

If the approach switch is on status, output current will be set MAX 100mA and max rate voltage will be 30V, therefore:

$$R_0 = U / I_0$$

$R_0 = 30V / 100mA = 300\Omega$ , if  $R_0$  is less than  $300\Omega$  that will have damage to the approach switch, so that resistance  $R_0$  is more than  $300\Omega$ .

In view of the above parameter relation like leakage current, output current, Max rate voltage and reset voltage for load PLC, resistance  $R_0$  value is  $300\Omega \leq R_0 \leq 6.25K\Omega$  and proponent value is  $4.7K\Omega$ .

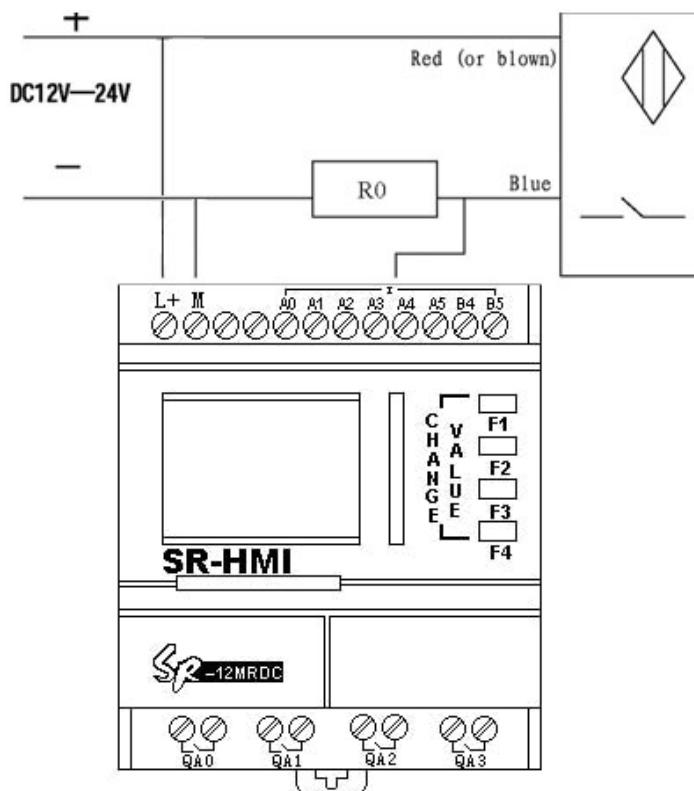
How impact the approach switch output is with PLC?

The approach switch with PLC connection diagram is above.  $R_0$  potential difference is regarded as PLC input voltage and resistance  $RL$  value is  $50k\Omega$ .

Here the equivalent resistance is below:  $R' = R_0 // RL = (R_0 \cdot RL) / (R_0 + RL)$

$300\Omega \leq R_0 \leq 6.25K\Omega$ ,  $RL = 50K\Omega$ , than  $RL \gg R_0$  so  $R' \approx R_0$ , PLC connection have no effect with the approach switch and it can be ignored.

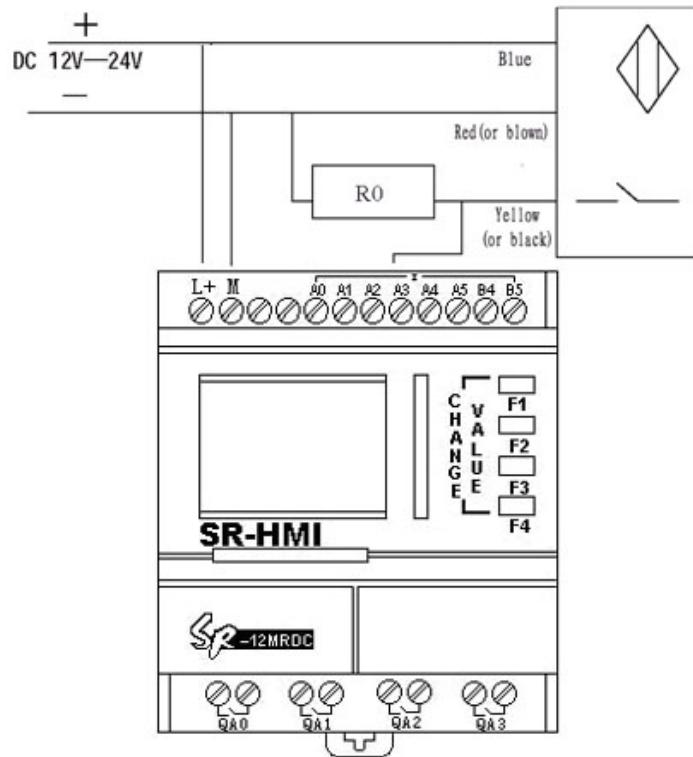
Connection diagram between SR-12MRDC and the approach switch is below:



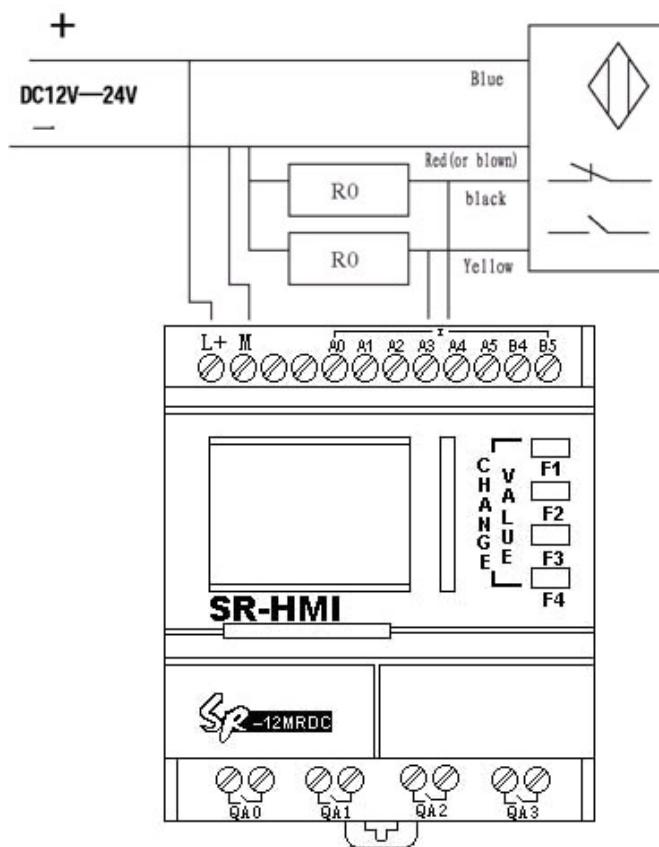
To the same type approach switch, its connection principle is alike. For NO and NC type approach switch, their difference is output relation when it near to

the approach switch. For 3-Line DC, 4-Line DC and 2-Line DC, their difference is their connection methods.

### 1. 3-Line inductive DC approach switch with SR

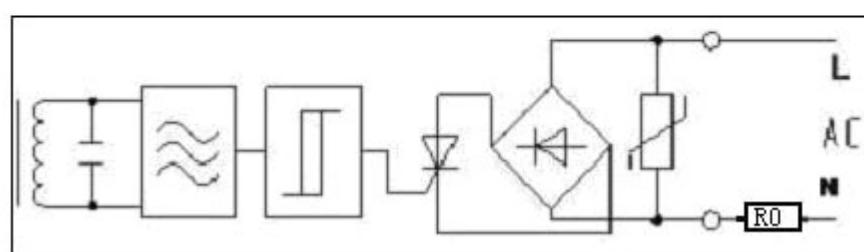
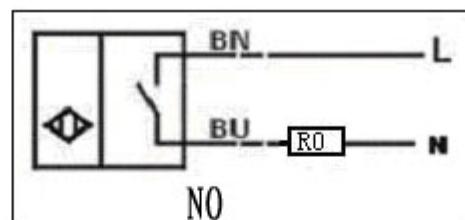


## 2. 4-Line inductive DC approach switch with SR

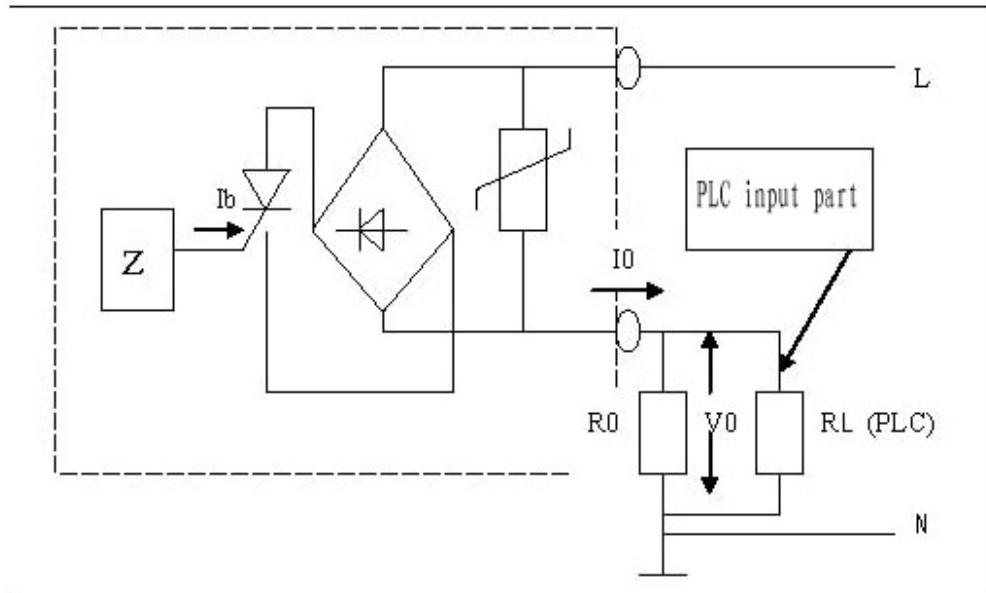


Example 2: Inductance double line AC approach switch with SR

Structure chart:



Equivalent circuit diagram:



Analyze resistance  $R_0$  value and connection sensor with PLC

In the equipment circuit diagram, virtual frame represents the approach switch;  $Z$  represents inductive component of approach switch;  $R_0$  represents the additional resistance;  $RL$  represents the equipment resistance of load PLC;  $I_b$  represents the output current of approach switch in the normal working;  $I_0$  represents output current of the approach switch; the voltage between  $L$  and  $N$  is used for supplying the drive voltage.  $\perp$  symbol represents the common reference electric potential, not the real earth. Like that, every electric potential in this

circuit is potential difference with this port. (i.e. voltage)

When the approach switch nears to metal, inductive component  $Z$  gives a current  $I_b$  into the thyristor control pole to drive its work, and  $I_0$  flows into resistance  $R_0$  which would have potential difference  $V_0$ , so PLC with parallel  $R_0$  has voltage input signal  $V_0$ . We give an example to analyze that  $R_0$  value has impact extent to the whole circuit.

Technical parameter for approach switch:

Input Voltage AC90V-250V, leakage current  $I' \leq 1.7\text{mA}$ , Output Current  $I_0 = 200\text{mA}$ ;

PLC Technical parameter: Type AF-10MR-A, Input Voltage 100V-240V, Input Resistance  $RL = 842\text{K}\Omega$ , Voltage range for 0 input signal is AC0-40V, Voltage range for 1 input signal is AC85-240V.

If the approach switch is off status, leakage current will be set MAX 1.7mA and max voltage for 0 input signal will be 40V.

Therefore;

$$R_0 = U / I'$$

$R_0 = 40V / 1.7mA = 23.5K\Omega$ , if  $R_0$  is more than  $23.5K\Omega$  that will cause error operation, so that resistance  $R_0$  is max  $23.5K\Omega$ .

If the approach switch is on status, output current will be set MAX 200mA and max rate voltage will be 250V.

Then  $R_0 = U / I_0$

$R_0 = 250V / 200mA = 1.25K\Omega$ , if  $R_0$  is less than  $1.25K\Omega$  that will have damage to the approach switch, so that resistance  $R_0$  is more than  $1.25K\Omega$ .

In view of the above parameter relation like leakage current, output current, Max rate voltage and reset voltage for load PLC, resistance  $R_0$  value is  $1.25K\Omega \leq R_0 \leq 23.5K\Omega$ .

In actual application for the approach switch in working order, assume power supply  $U = AC 220V$ , resistance  $R_0 = 20K\Omega$ .

Then  $I_0 = U / R_0$

$$I_0 = 220V / 20K\Omega = 11mA$$

Resistance Power  $P_0 = I_0 * I_0 * R_0$

$$P_0 = 2.24W$$

So resistance  $R_0$  will generate heat in working order under this voltage, it is necessary to chose greater power for resistance to prevent damaging.

Recommendation: When AC is 110V, use resistance  $R$  of  $10 K\Omega$  3W/5W

When AC is 220V, use resistance  $R$  of  $20 K\Omega$  10W/20W

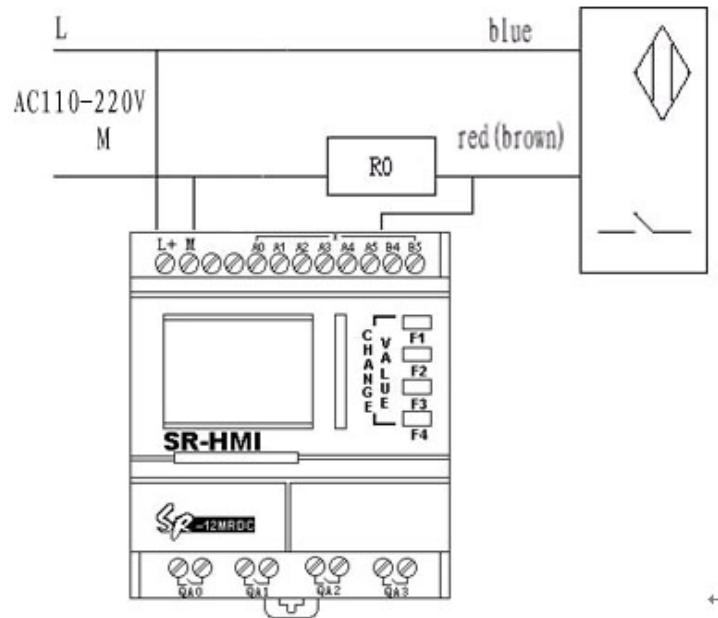
(If heating is enough greater, please change greater power resistance)

How impact the approach switch output is with PLC?

First connect PLC with  $R_0$  parallel,  $R_0$  potential difference is regarded as PLC input voltage and resistance  $RL$  value is  $842K\Omega$ , here the equivalent resistance is below:  $R' = R_0 // RL = (R_0 \cdot RL) / (R_0 + RL)$

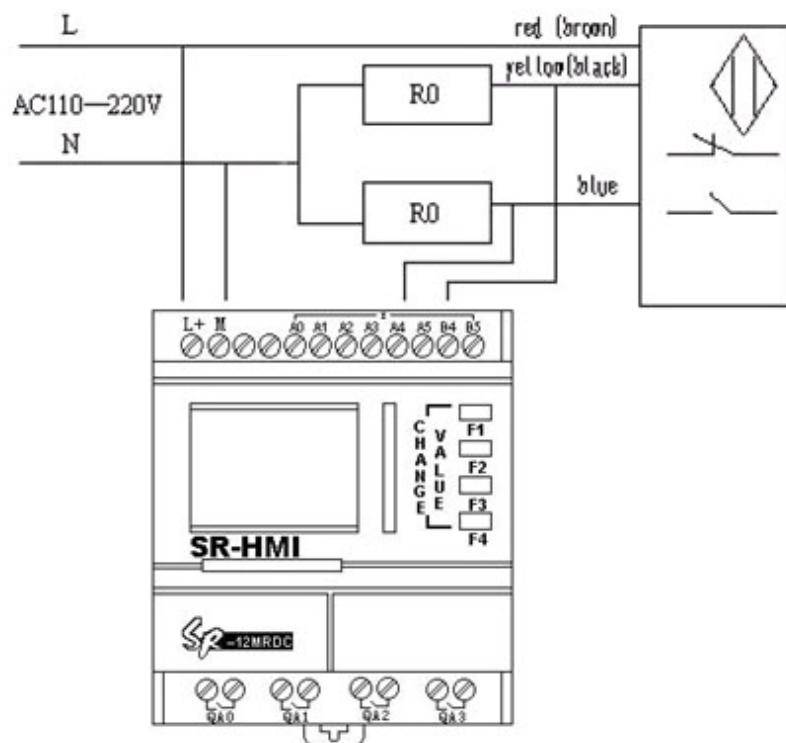
$1.25K\Omega \leq R_0 \leq 23.5K\Omega$ ,  $RL = 842K\Omega$ , than  $RL \gg R_0$ , so  $R' \approx R_0$ , PLC connection have no effect with the approach switch and it can be ignored.

Connection diagram between the approach switch and AF-10MR-A is below:

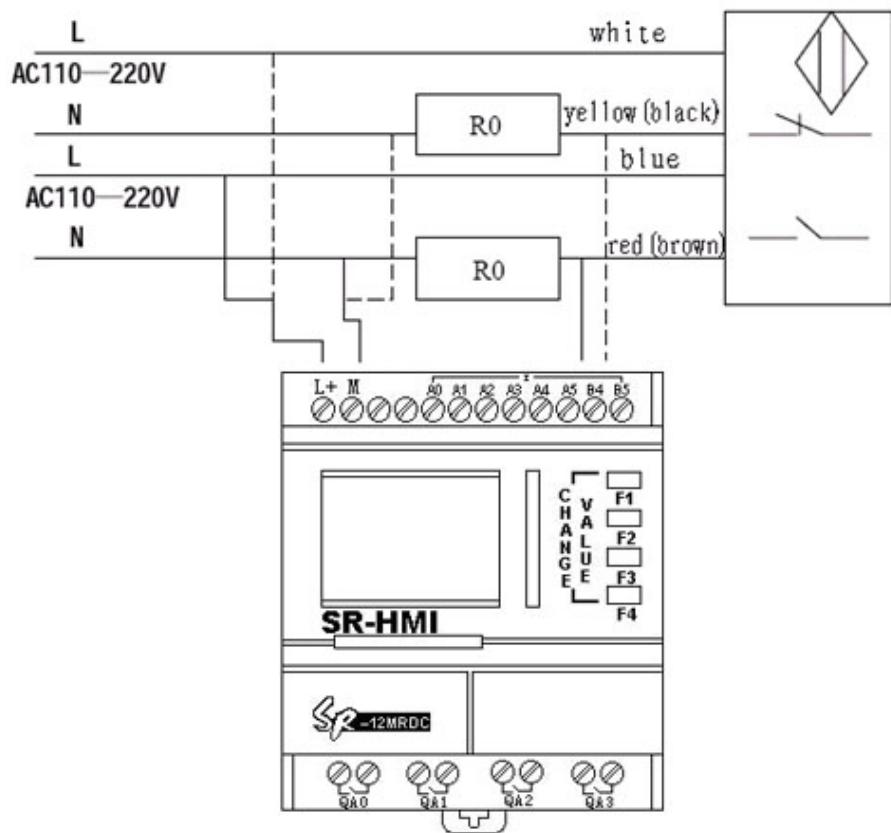


To the same type approach switch, its connection principle is alike. For NO and NC type approach switch, their difference is output relation when it near to the approach switch. For 3-Line AC, 4-Line AC and 2-Line AC, their difference is their connection methods.

## 1. 3-Line inductive AC approach switch with SR



## 2. 4-Line inductive AC approach switch with SR



## **Conclusion**

1. In view of the above analysis, it is important to connection method with the periphery circuit.
2. SR has not only digital input function, but also analog input function.
3. The above analysis is summarized successfully through the strict test.
4. Connection method between all kinds of sensor, detectors and SR can refer to the above illustration, if you have any doubt, please contact us in time.