A superior practical protection and control circuit for 24 v power supply

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Abstract. Protection and control circuit is indispensable part of the precious, precision electronic equipment which use 24v power supply. This paper introduces a kind of protection and control circuit which is superior performance, simple, economical and practical of 24 v power supply control circuit.

Introduction

The protection and control circuit has the function of over-current protection, over-voltage protection, under-voltage protection, under-voltage warning to 24 v power supply and the precious, precision electronic equipment（Hereinafter referred to as a peripheral）.It can also do power-off protection and instructions when the peripheral using current over 30A or voltage over 32V or below 19V，and do warning instructions but not power off when voltage below 21V or over 19V.

Composition

The protection and control circuit is composed of reference voltage circuit, voltage sampling circuit, voltage comparison circuit, control circuit, indicator light circuit, power circuit. The circuit composition is shown in figure 1.

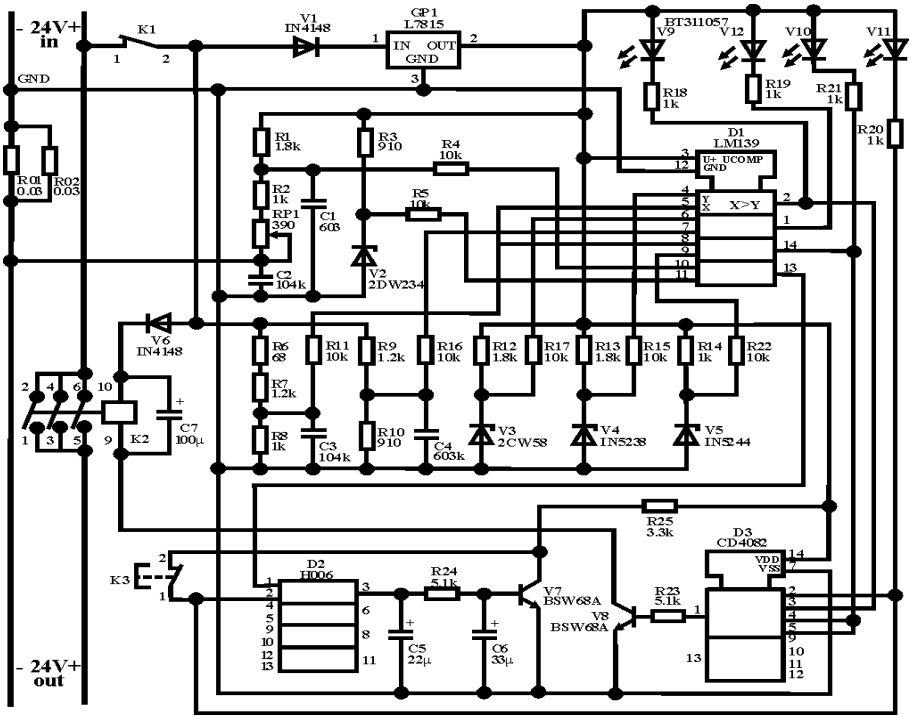

Fig. 1 The protection and control circuit Composition figure

The power supply circuit. The power supply circuit is composed of diode V6, V1 and three-terminal voltage regulator of GP1.

Reference voltage circuit. Over current reference voltage circuit is composed of resistance R3, R5 and 6.2 V zener diode V2.Over voltage reference voltage circuit is composed of resistance R14, R22 and 4.3 V zener diode V5.Under voltage reference voltage circuit is composed of resistor R13, R15 and 8.5 V zener diode V4.Warning reference voltage circuit is composed of resistance R12, R17 and 10.2 V zener diode V3.

Sampling voltage circuit. Flow sampling voltage circuit is composed of resistor R1, R2, R4, potentiometer RP1 and capacitor C2, C1, and the resistance of R01, R02.Overvoltage and under voltage sampling circuit is composed of resistance R6, R7 and R8, R11 and capacitor C3.Warning sampling voltage circuit is composed of resistance of R9, R10 and R16 and capacitor C4.

Voltage comparison circuit. The voltage comparison circuit is composed of four voltage comparator D1.

Control circuit. Flow control circuit is composed of 4-2 input nand gate D2 group 1, switch triode R24, R25 V7, resistance, capacitance C5, C6 and over voltage control circuit, under voltage control circuit, early warning and control circuit of common public four input and double door D3, resistance R23, switch triode V8 and relay K2, the capacitance of the C7.

K1 is the power switch of the control and protection circuit; K3 is the "power reset" button switch.

Indicator light circuit. Light has under voltage, over voltage, over current, early warning and so on four kind of light，which is composed of the light emitting diode V9, V10, V11, V12 and R18 resistor, R21, of R20, R19 respectively.

Working principle of power circuit. The external 24V power supply is sent to the 2, 4, 6 contacts of relay K2, and to the positive pole V6, V1 and one end of R6, R9 through the power switch K1.

24V power supply will be sent to the line package 10 pin of relay K2 by the negative pole of V6, and the 9 pin is controlled by V8, D3. Under normal circumstances, 2, 3, 4, 5 pin of D3 has 3 road of high level input, pin 1 outputs high level, which makes the V8 conduction, pin 9 of K2 on 24 v, and relay K2 action, 1, 3, 5 pin and 2, 4, 6 pin through, external 24 v power supply into the peripherals. Once the peripheral has over current, over voltage, under voltage and any other abnormal condition, the 9 pin in the D3, V8 control, can not connect to 24V, relay K2 no action, 1, 3, 5 and 2, 4, 6 pin off the external 24V power to peripherals, peripherals stop working, get protection.

24V power supply will be sent to 1 pin of GP1 by the negative pole of V1,whose 3 pin is electrical grounding and 2 pin outputs 15V to D1、D3、R1、R3、R25、R20、R12、R13、R14。The 15v is also sent to the positive pole of under voltage, over voltage, over current, early warning indicator which is light-emitting diodes composed of V9, V10, V11, V12.

Working principle of over current circuit. The current sampling voltage is taken from the R1 and the R2 connection end, and the R4 is sent to the D1 fourth comparator 10 pin (Y), the over current reference voltage is taken from the R3 and the V2 connection end, and the R5 is sent to the D1's fourth comparator 11 pin (X).

When the peripheral normal operating current is less than 30A, the over current reference voltage is higher than the X (Y), and the output end of the D1 is 1 pin high to D2.

2 pin of D2 and D3 signal, due to the current V7, its C output 15V high level, send to the "power" button switch K3 normally closed contact 2, 1 pin, to reach the D2 2 pin, D3 2 pin and the R20 through the current limiting resistor V11 to the negative electrode, so that it remains high[1].

Through the above analysis, obviously the 1, 2 pin of nand gate D2 are of high level, the 3 pin outputs low level, so the V7 can be continued. Because of the high level of 2 pin of D3, the output of 1 pin of D3 keeps high level, V8 keeps conduction, and the peripheral maintains working normally. The flow indicator V11 has no light because of its positive pole picking up to 15 v power supply whose level is the same with the negative pole.

Once the peripheral has the current situation, the current benchmark voltage is lower than the X (Y), the 13 pin of D1 output is low to D2 1, D2 3 pin output high level, V7 K3, its C output low level, which is sent to the negative pole through V11, and lights the over current indicator；The

low level which is sent to the pin 2 of D2 and pin 2 of D3, makes the pin 3 of D2 output high level which maintains V7 conduction, and pin 1of D3 output low level which stops V8 and relay K2 interrupt, so that each contact tripping, the supply of peripherals is cut off. Since the K1 is not disconnected, the circuit has always been on the electricity, and the flow indicator light remains lit.

If the peripheral power protection is caused by transient over current, you can press “power reset” button switch K3 one time, so that the 2 pin of D2 and D3 can be out of the low level, then the 3 pin of D2 outputs low level which stops V7, while the 1 pin of D3 outputs high level enabling V8 conduction, relay K2 action, each contact be connected, so the peripheral power can continue working.

Working principle of over-voltage circuit. Over voltage sampling voltage is taken from the R7 and the R8 connection end, the R11 is sent to the D1 third comparator 8 pin (Y), the voltage reference voltage is obtained from the R14 and the V5 connection end, and is sent to the D1's third comparator 9 pin (X) by R22.

24V power supply or peripheral normal operating voltage is not greater than 32V, over voltage reference voltage (X > Y), the 14 pin of D1 outputs high level, one road of which is sent to 4, 5 pin of D3, the 1 pin of whose outputs high level maintaining V8 conduction. The other road is sent to the negative pole of V10 through the current limiting resistor R21, which makes the negative and the positive pole have the same level, so the overvoltage indicator is not bright[2].

Once the 24V power supply or peripherals have the condition of over voltage, in which over voltage reference voltage (X < Y), the 14 pin of D1 outputs low level, one road of which is sent to the negative pole of V10 which can be lighten through the current limiting resistor R21.Another road is sent to the 4, 5 pin of D3, the 1 pin of whose outputs low level which cuts off V8, interrupts K2 relay, trips each contact, and then cuts off power supply of peripheral. Similarly, since the K1 is not disconnected, the circuit has always been on the power, while the overvoltage indicator light remains lit.

Working principle of under voltage circuit. Under voltage sampling voltage is also taken from the R7 and R8 connection end, the R11 to the D1 of the first comparator 5 pin (X) [3], the voltage reference voltage from the R13 and the V4 connection end, the R15 to D1 by the first comparator 4 pin (Y).

When the 24V power supply or peripheral normal operating voltage is no less than 19V, the voltage sampling voltage is higher than the reference voltage (X > Y), the 2 pin of D1 outputs high level, one road of which is sent to D3's 3 pin, the 1 pin of whose outputs high level maintaining V8 conduction. The other road is sent to the negative pole of under voltage indicator V9 through the current limiting resistor R18, which makes the negative and the positive pole have the same level, so the overvoltage indicator is not bright.

Once the 24V power supply or peripherals have the condition of under voltage, in which under voltage reference voltage (X < Y), the 2 pin of D1 outputs low level, one road of which is sent to the negative pole of V9 which can be lighten through the current limiting resistor R18.Another road is sent to the 3 pin of D3, the 1 pin of whose outputs low level which cuts off V8, interrupts K2 relay, trips each contact, and then cuts off power supply of peripheral. Similarly, since the K1 is not disconnected, the circuit has always been on the power, while the overvoltage indicator light remains lit.

Working principle of early warning circuit. The warning sampling voltage is taken from the R9 and the R10, and the R16 is sent to the D1 of the second comparator (X), and the reference voltage is taken from the connecting end of the R12 and the R17, and the V3 is sent to the D1's second comparator 6 pin (Y).

When the 24V power supply or peripheral normal operating voltage is no less than 21V, the warning sampling voltage is higher than the warning reference voltage (X > Y), the 1 pin of D1 outputs high level, which is sent to the negative pole of warning voltage indicator V12 through the current limiting resistor R19, which makes the negative and the positive pole have the same level, so the warning indicator is not bright.

Once the 24V power supply or peripheral working voltage is lower than 19V and greater than

21V, the warning sampling voltage is lower than the warning reference voltage (X < Y), the 1 pin of D1 outputs low level[4], which is sent to the negative pole of warning voltage indicator V12 which will be lighten through the current limiting resistor R19.

Conclusion

According to the above principle analysis, the control and protection circuit entered into the three kinds of control protection status such as over current, over voltage or under voltage once, it need to be powered off, and the external power equipment or 24V power for needs to be repaired; While, when the circuit entered into the early warning state, it can be repaired after shutting down K1 timely and cutting off the power on the situation.

This circuit achieves over-current protection performance requirements by adjusting the RP1[5], reaches the performance requirements of overvoltage protection by adjusting R6 resistance, achieves under voltage protection requirements by adjusting V4 parameters, reaches warning performance requirements by adjusting parameters of V3.

It can be known that the circuit can be extended to the use of electrical equipment and auxiliary power supply for different voltage by replacing the parameters of parts of components.

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