Design to conditioning circuits of dynamic compensation of reactive power in the intelligence voltage controller

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Abstract —**The paper introduces one design idea that making use of SCM to control Real-timely the dynamic compensation of reactive power. Firstly, design one Circuit to Sample the voltage and current , and by these datas we can easily calculate the power factor , and Voltage controller in the microcontroller to determine whether input the compensation capacitance according to the size of power factor, the paper also analyzes the principle of capacitance compensation and calculation method 。 Dynamic compensation for the entire process is quick and accurate.**

Keywords*—*reactive power compensation ; Real-timely control; dynamic ; power factor

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1 Introduction

At present, when the inductive load is less, there is comparatively mature intelligent control devices for lighting, which can implement the lighting of regulatory, effectively protect the electric light and reduce power consumption as so on. But in some lighting system, if using too many lamps which are inductive loading, Power system will be a great deal of reactive power, and make the network's power factor lower to affect the electrical power and network system's safety and function efficiently. So improve the network's power factor is very important, which can make the reactive power balanced and reduce the loss of wire, improve the quality of the voltage.

2 The structure of the intelligence voltage controller

We have studied the lighting systems and propose the thought of intelligent control on the base of regulating the voltage ,the 51MCU is used as controller, the intelligent regulate voltage control system contains regulating voltages, sampling of the current and voltage , power compensation etc. This article will emphasizely introduce the power compensation and voltage and current's sample. The sampling circuit make the voltage and current and phase to digital form hand down MCU, according to the sample value and power factor, MCU forecast and control whether or not put into the C .figure 1 is the structure diagram of the intelligence lighting controller system：

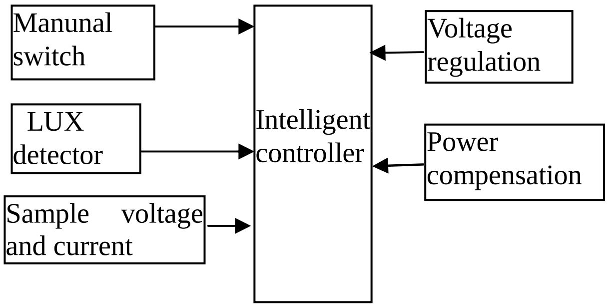

Fig.1 Intelligent lighting control system

3 The sample of voltage and current

The sampling circuit of voltage-current is shown in Fig2.It transmits the digital voltage, current and phase in circuit to the microcontroller, and the microcontroller carries out the forecast and control according to the sampling value.

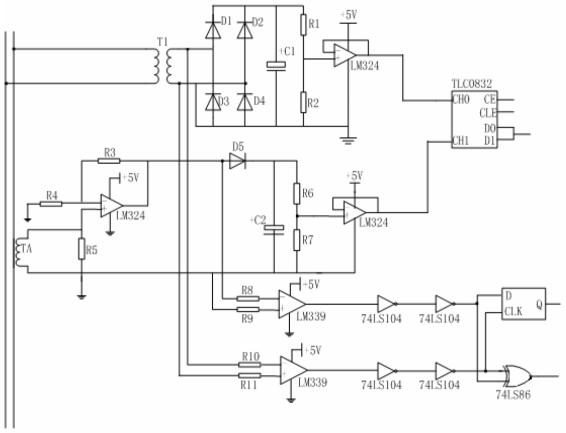

Fig.2 the sample circuit of voltage and current

The mutual inductor transforms the voltage and current of the lighting circuit to the secondary side, the two kinds signals are divided into two roads, one is A/D after amplification, rectification and follow by IN0 and IN1 channel of TLC0832, the other is sent to LM339 changing AC signal to square signal. The

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square signals reflecting the line voltage and current phase are XOR by 74LS86, the width of output impulse is the phase difference of line voltage and current Φ. Those square signals reflecting line voltage act as the clock of 74LS74,the other signals act as the input signals of 74LS74, the rising edge of D-flip flop is effective, when the output is low ,it shows that the voltage is ahead of current ,the lightening system is inductive loads, otherwise capacitive loads. If there is no impulse output in the XOR, the phase of voltage is the same as current, the system is resistive loads. The time of sampling circuit is controlled by microcontroller, by the way of interruption or search..

4 Dynamic reactive compensation

When the lighting energy saving systems used inductive loads widely, there will be a lot of reactive powers; the power factor of power grid is extremely low. It influences the security and efficiency of power system. Therefore, improving the power factor to balance the reactive power, reduce the line loss, improve the quality of voltage is very important work.

Dynamic reactive compensation circuit consists mainly of fixed compensation capacitor, high-power SCR and an inverse parallel unsaturated reactor, as shown in figure 3 below. L_1 and L_2 is the inductance stopping the high frequency harmonics. Because the current flows by reactor are under the phase-shifting control of SCR, the susceptance of capacitance and inductance parallel branch varies from the range of capacitive segment and inductive segment. It can adjust the reactive power continuous supplied for power grid, completing dynamic stepless power factor compensation of lighting system. The shunt capacitance and inductance equivalent electric susceptance is:

$$b = j(\omega C - \frac{2\pi - 2\alpha + \sin 2\alpha}{\pi\omega L})$$

(3.10)

α is the trigger angle of SCR. When α =π / 2 and 1/ωL >ωC, b = − j[(1/ωL) -ωC],the circuit is inductive, parallel branch circuit gets the reactive power from the power grid. When α =π, b = jωC, the circuit is capacitive, parallel branch outputs reactive power to the power grid. Normally, parallel branch varies in the capacitive and inductive, and its electrical susceptance relates with control angles. If cosφ is low, the output signals of control device increase the SCR trigger angle, making parallel branch provide more reactive power demand of leading reactive power compensation inductive load to power grid, improving the power factor of load. Because the SCR trigger angle can change continuously, the compensation is dynamic.

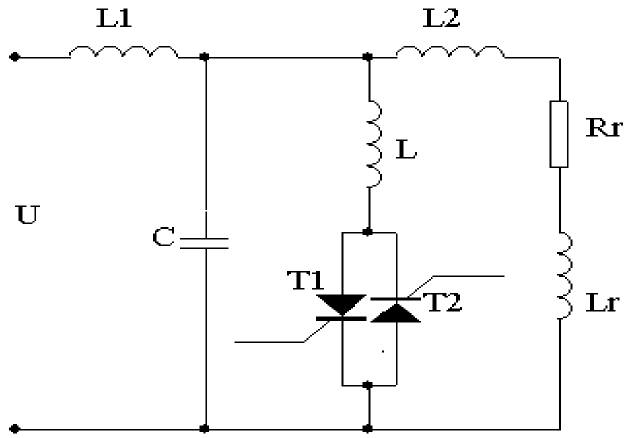

Fig. 3 schematic circuit diagram of dynamic reactive compensation

Capacitor C is used to compensate reactive power and improve the power factor. When lighting lamps in the stadium power-on, due to the lamps being inductive device, power factor in the circuit is lower. Take fluorescent light for example, power factor generally is 0.5 - 0.6. For the sodium lamp 400W, when the supply power is 220V, whose current is 4.1A, input apparent power is 4.1 × 220 = 902VA. But the actually active power is only about 480W, it shows the active power from the power grid is only 53.2%. if C was thrown into the circuit, the phase difference of the current lag behind the voltage will be decrease, so as to improve the power factor. The active power from the power grid will increase, This states that compensation device will greatly reduce the energy losses, and then saving energy. Dynamic reactive power compensation circuit is shown in Figure 4. For the capability of MCS-51 is limited, the output signal after amplification by 7407 and C filter is sent to the photocoupler, whose output is photosensitive bi-directionnal thyristor, but also equiped with zero-crossing detection circuit, used to control the thyristor trigger.

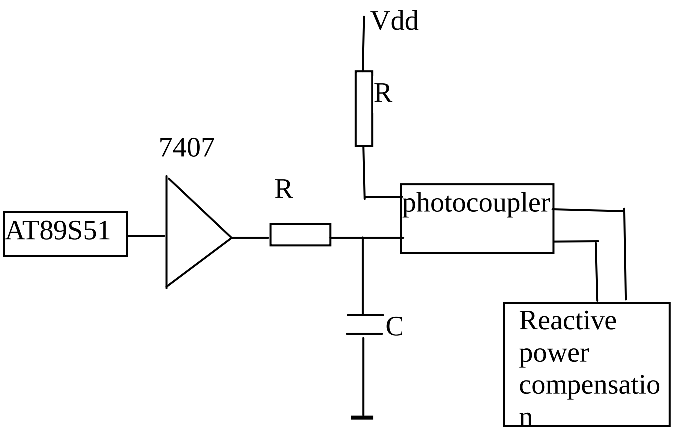

Fig.4 Dynamic reactive power compensation output circuit

The circuit is controlled by microcomputer. Sampling the load current, voltage and power factor , by ADC the datas are sent to the microcontroller, and according to the setting power factor values (eg 0.95), the MCU automatically control single thyristor trigger pulses to make power factor compensated. Microcontroller samples these parameters once every 30ms, and then calculate the instantaneous power:

P=3UI cosφ1 ;

In the formula: U - load voltage, kV;

I - Load Current, A;

cosφ1 - instantaneous power factor.

To improve the power factor cosφ1 to cosφ2 , it requires compensation capacity of shunt capacitors:

Q_C =P(tanφ1-tanφ2) =3UIcosφ1(tanφ1-tanφ2)

In the formula: φ2- the improved power factor angle.

Per phase needing capacitance of capacitor values, use triangle Connection

$$C = \frac{Q_C \times 10^3}{3U^2 \omega} \mu F$$

In the formula: U - the network line voltage, KV; ω - angular frequency.

In the control processing, the MCU sampling load current, voltage and power factor per 30ms, when the power factor less than 0.95, immediately calculate the compensation capacitance required, and also instruct which groups of compensation capacitors to put into, thus it can be timely and accurately put the power factor increased to 0.95. When the load power factor is greater than 0.99, the MCU immediately calculate the compensation capacitance to cut off, and give out instructions to remove which groups of compensation capacitor, so avoid going beyond, make the power factor less than 0.99.

The dynamic compensation process is fast and accurate. As the real-time control of microcomputer, the system power factor is will not be lacking, but also not go beyond.

5 Summary

From the last testing results of prototype, the dynamic reactive compensation is quick and accurate, and reach the expected purposes and demands.

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(From P.96)

From the above waveforms,the output result basically satifies the design requirments and the amplitude can be controlled by the words rightly.The frequency values displayed on oscilloscope are shown as table 1:

TABLE 1 THE OUTPUT FREQUENCIES

STANDARD DATA	1Hz	100Hz
MEASURED DATA	1.001Hz	100.025Hz
TOLERANCE	±3.5%	±3.5%

From the tableI,it is known that the output frequencies are correct.

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