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Research & Development of Three-Phase Full - controlled Bridge Rectification Circuits Experiment Device Based on TC787

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Abstract. The work principle of TC787 are explained, including the function of each pin. The design idea about trigger circuit are given. And the structure and feature of main circuit is presented. Finally the experiment results are educed. A new design for three-phase full-controlled circuit system was introduced, which was based on TC787.This system, which was in application to TC787 instead of KJ/KC, was more reasonable and convenient, as well as more reliable and less cost in power. It had a wonderful application foreground in power electronics field.

Introduction

With the development of technology, integrated circuit is more and more applied in the field of control system of power electronics, has brought great convenience for the miniaturization of electronic products and engineering design. Since application of the three-phase fully controlled bridge rectifier circuit into the comprehensive practice teaching, the design and development of experimental training device not only meet the teaching requirements of power electronics, but also meet the need of training requirements for the skilled, application-oriented and inter-disciplinary talents of automatization specialty.

TC787 integrated trigger

Advanced and unique IC technology is used in TC787 (A, B), a monolithic integrated circuit, is designed according to the latest foreign integrated phase-shift trigger integrated circuit, single power supply, can also be double power supply, mainly is suitable for the three-phase thyristor trigger circuit and three-phase power transistor pulse width modulation circuit, to form a variety of adjustable pressure, adjustable speed and variable flow device. They are currently popular products of TCA785 and KJ (or KC)series of phase-shift trigger integrated circuit on the domestic market,TC787 is widely used in of three-phase fully controlled, three-phase half controlled, three-phase zero power electronic and integration of mechanical and electrical products' phase shifter trigger system, in order to increase the machine life, reduce the volume, provides a new and more effective ways to reduce costs.

Circuit using standard 18 pin plastic shell and dual in line package, the chip can be free to plug in the socket. The name, the pin function and usage as described in the following table:

The pin number	Function and usage
18, 2, 1	Synchronous voltage input, respectively connected with the synchronous voltage after filtering
12, 11, 10, 9, 8, 7	Pulse output, single pulse mode respectively corresponding to A, -C, B, -A, C, -B. Double narrow pulse mode respectively corresponding to A, C, -C, B, B, -A, -A, C, C, -B, -B, A
16, 14, 15	The corresponding three-phase synchronous voltage sawtooth capacitors Ca, Cb, Cc connection end

13	Cx capacitor connection end, its capacitance determines the output pulse width, the capacitance is greater, the output pulse width is more wide
6	Working set end, the end is connected with a high level, the output is double pulse train; then when low, single pulse train output
5	The output pulse is used to output the ban, blockade TC787 output in the fault state. High level no pulse output, low level work
4	Phase control voltage input, the voltage maximum is operating supply voltage U_{DD}
3, 17	Pin 3 (VSS) is grounding when Single supply operation, pin 17 (VDD) allow the applied voltage is 8~18V. When dual supply operation, pin 3 is connected with the negative power supply ,which allows the voltage applied is -4~-9V, VDD) with a positive power supply. Pin 17 (VDD) with a positive power supply, allowing the applied voltage is +4~+9V

Design of triggering circuit

Three-phase 6-pulse trigger circuit consisting of TC787 as shown in figure 1. 380V three-phase alternating current transform into synchronization signal a1，b1，c1 for 30V through synchronous transformer, through the potentiometer RP1, RP2,RP3 and RCT type network filter access to the synchronous voltage input end of the TC787, by adjusting the RP1, RP2, RP3 to adjust the phase of each phase voltage inching, to ensure matching the synchronization signal and the main circuit. Ca, Cb, Cc capacitor, which decides the sawtooth wave linear, the amplitude of TC787 chip, therefore, in order to ensure sawtooth wave good linear and the consistency of three-phase sawtooth slope, relative error of Ca, Cb, Cc 3 capacitor value selection is very small. In order to produce good linear of sawtooth waveform, large amplitude and not flat, the best selection of Ca, Cb, Cc capacitance value is 0.15 μ F. Capacitor Cx connected to the 13 pin determines the output pulse width, larger Cx, pulse width is more wide, but the pulse width is too wide that will increase the driver stage loss, so the Cx value should be in the range of 3300pF-0.01 μ F, 0.01 μ F selection in here. Regulation of RP can make the input voltage of 4 foot change continuously in the 0- VDD, so that the output pulse changes between 0 ° -180 ° ,7-12 foot output end's output capacity is greater than 20mA, use the 6 driving pipe extending current, output the pulse after pulse transformer isolation.

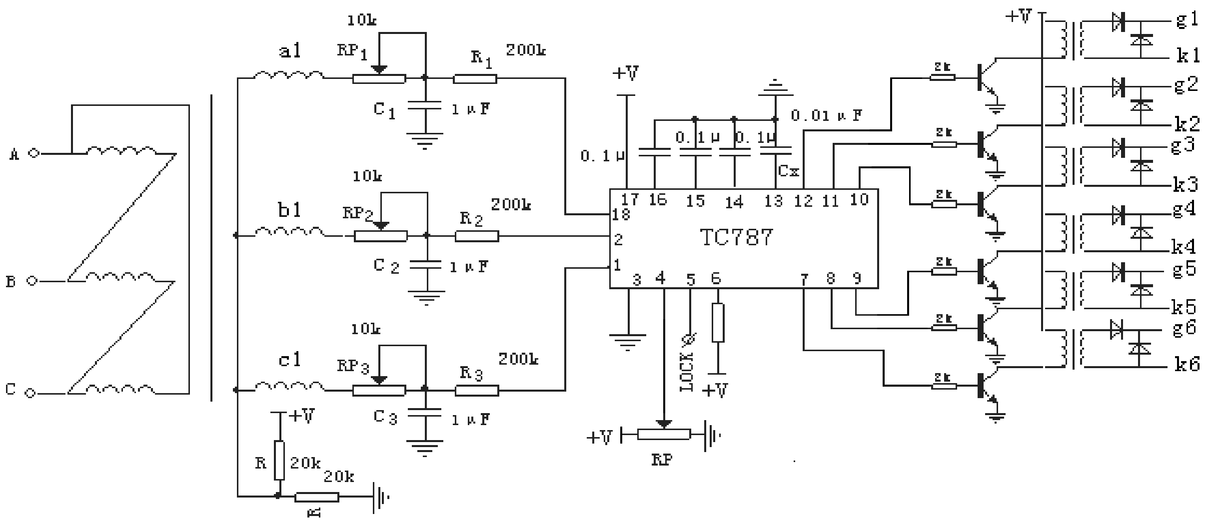

Fig. 1 TC787 three-phase 6-pulse trigger circuit

Welding circuit according to figure 1 and after check correct, the control knob to zero (i.e. RP1, RP2, RP3 resistance, RP access to the circuit in the maximum), and then connect the power, observe pulse waveform using the oscilloscope, the waveform of figure 2 is the pulse waveform of the G, K both ends in the process of debuggingRP1, RP2,RP3, RP.

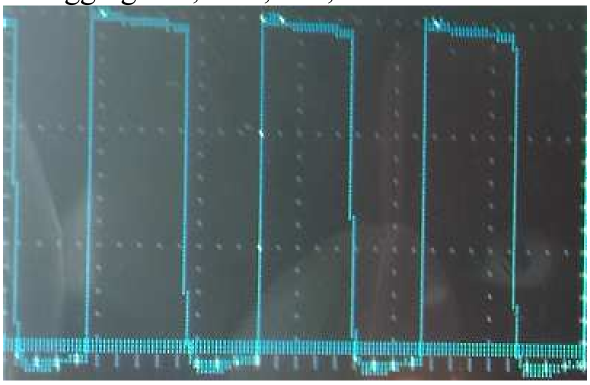

Fig. 2 The output pulse waveform of G, K both ends

The main circuit design

Schematic diagram of the main circuit as shown in figure 3. The trigger circuit six outputs pulse according to priority are respectively connected with the control electrode and the cathode electrode of the six thyristor tube, to trigger the thyristor. Thyristor conduction according to VT1, VT2, VT3, VT4, VT5, VT6 sequence in turn, each tube of 120 °, 60 ° at intervals by a thyristor switched to a thyristor. Common cathode group and common anode group each have a thyristor conduction, can constitute the passage of current.

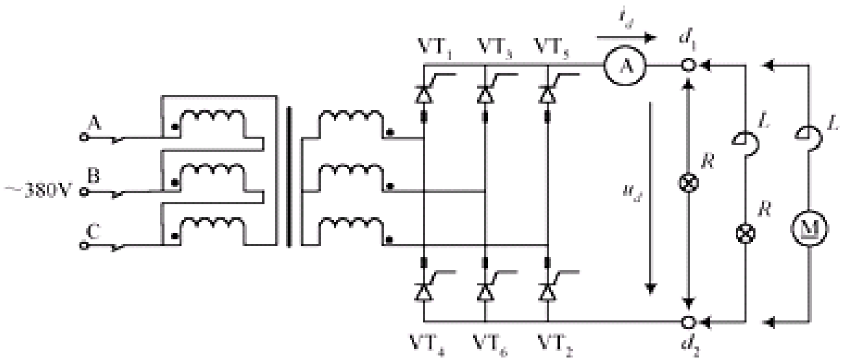

Fig. 3 Schematic diagram of main circuit

The debugging results

(1) Connected to power supply of the trigger circuit, pulse waveform in oscilloscope.

(2) The main circuit switch on the power, adjust RP to observe load waveform by oscilloscope Whether it is zero, if not zero, regulate RP1, RP2, RP3 to zero, and the waveforms are lined up in neat.

(3) Adjust control voltage potentiometer RP to make the main circuit output voltage Ud change, record the voltage waveform of α =0 °, 30 °, 60 °, 90 °, 120 °.

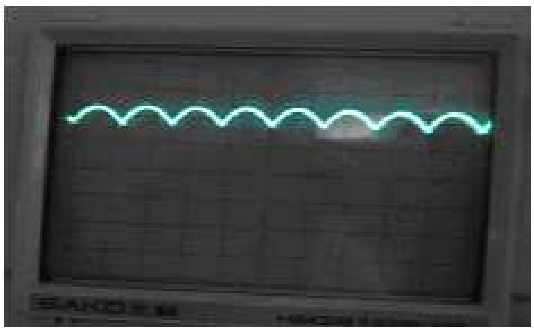

Fig. 4 Ud voltage waveform below α =0 °

Output voltage waveform is given below α =0 °.

Figure 4 and figure 5 two picture shows similar, debugging waveform and theoretical debug waveform is no difference on the basic.

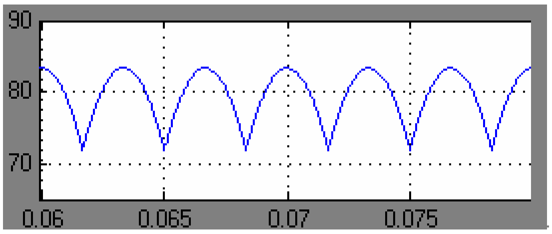

Fig. 5 Ud voltage waveform below α =0 ° as MATLAB simulation

Instructions and the needing attention matters

(1) In order to reduce the interference of using circuit, adopts the same shape △/Y transformer in trigger circuit and main circuit, in order to reduce the harmonic of circuit.

(2) Circuit adopts centralized constant current source charging to the capacitor, after testing, the current in the about 180 μ A, the relative error is less than ± 5 μ A, so in order to ensure the consistency of the three-phase sawtooth wave, the relative error of capacitor selection should be less than 5%. When 50Hz, capacitance desirable is about 0.15 μ F, higher frequency, in order to ensure capacitor integral amplitude, capacitance should be reduced.

(3) The adjustment amplitude of phase voltage and the integrating capacitor's sawtooth should be consistent. Considering the discrete distribution of discharge in the integrating capacitor circuit, zero potential of phase voltage should be better 200mV than the negative power supply, the phase shift is the range of 0.2 ~ 13V.

(4) Capacitor Cx of pulse generator determines the modulation pulse width or square wave output width, capacitance is greater, width is more and more wide. The frequency of 50Hz cases, when 0.01 μ F capacitor, its output width is about 0.5ms, if needs to output in the 0 ° to 180 ° with adjustable amplitude, Cx value should be greater than 0.2 μ F.

(5) Circuit controlled half / full and prohibition control end, should not be suspended when in use.

(6) If the output current is not less than 20mA, the drive pipe must be switched on and off, the output limiting current and the βvalue should be matched with the circuit.

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