VOLTAGE CONTROLLED PULSE WIDTH MODULATOR

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Abstract

This paper presents a model for a voltage controlled pulse width modulator (VCPWM), which can be used in any phase controlled converter having either manual or microprocessor based control. The circuit uses only one 555 timer, an OpAmp, some resistors, and capacitors. Although a large varieties of such circuits are available in the literature, this model is very simple with low cost and high performance.

1. Introduction

Ozone is attracting increased attention as a pollution free oxidant in a very wide application. These include treatment of drinking and waste waters in both the household and industry (depolarization, depolarization, disinfection), in the cleaning and disinfection of contaminated water and air (swimming pool, bath, hospital, biohazard control), in the ozone aching of photoresist film in micro electronic industries and even in the desulphurisation($DeSo_x$) and denitrization ($DeNo_x$) of combustion gas from large utility boilers[1][2].

The size reduction of an ozonizer and its power supply is possible by using ceramic based ozonizer , using high frequency discharge [3]. The authors have designed a high frequency and high voltage power supply. The block diagram is shown in fig. 1

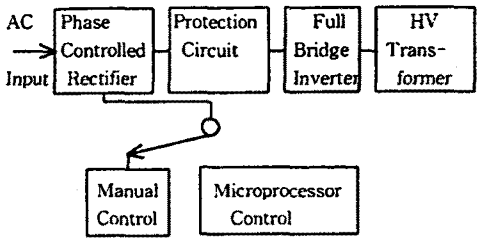

Fig.1. Block diagram of the overall scheme.

Fig.2 shows the block diagram of the control electronics. Depending on the control signal the rectifier voltage varies from 0 to 210 [volts]. The signal varies from 0 to 5 [volts] which corresponds to 180° control in the power supply. Since the control signal varies from 0 to 5 [volts] the signal can be given either manually or through microprocessor based control program.

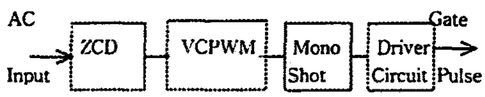

Fig. 2. Block diagram of the control scheme.

2. Circuit configuration

The circuit is shown in figure 3. Taking the advantage of the monoshot operating mode of 555 timer, we can connect an OpAmp as shown [4]. Pin 3 is used as input pin and the negative input of OpAmp will be used as control signal input.

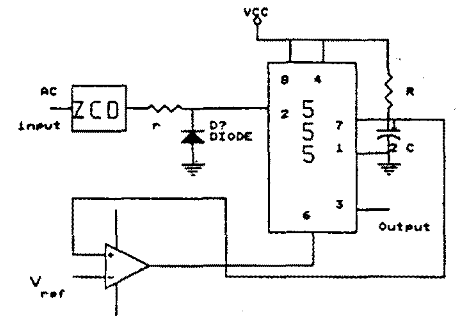

Fig. 3. Diagram of the VCPWM.

At each negative edge of the triggering signal applied to pin 2, the timer is set and the capacitor starts charging. The capacitor voltage is compared with the control signal applied to the OpAmp. So, as soon as the capacitor voltage reaches the control signal, the timer resets . So, the charging time, which is the width of the output pulse depends on the reference signal V_r . The equation can be written as

$$T_p = RC\log_e \frac{V_{cc}}{V_{cc} - V_{ref}}$$

where,

T_p = Output pulse width

V_{cc} =Biasing voltage

V_{ref} =Control signal (Reference voltage)

Table 1 gives the values for firing angle delay against the control signal. For a 50 [Hz] power supply frequency, the half period is 10 [ms] which corresponds to 180° (full conduction period of one device). In this model with RC=3.96 [ms] for a reference signal of 4.6 [v] (for a 5 volt biasing), the dc output voltage is zero.

Table 1. Values of the firing angle versus control signal.

V_{ref}	0	1	1.5	2.0	2.5	3.0	3.5	4.0	4.25	4.5	4.6
T_d	0	0.88	1.41	2.02	2.74	3.62	4.76	6.37	7.51	9.11	10.0
Firing Angle (deg)	0	15.89	25.38	35.36	49.32	65.16	85.68	114.6	135.2	164.0	180

3. Experimental results

3.1 Manual control

The above scheme was used to vary the speed of a 1 [HP] dc motor. A feedback system involving PI controller in the feed back path was used to get better performance. Fig. 4 shows the block diagram for the motor control application. Fig. 5 shows the dc output voltage versus reference signal.

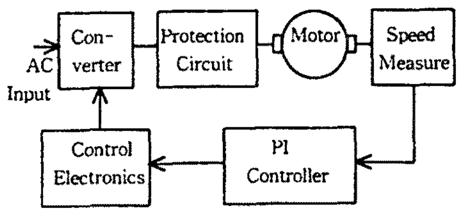

Fig. 4. Block diagram of the motor control application.

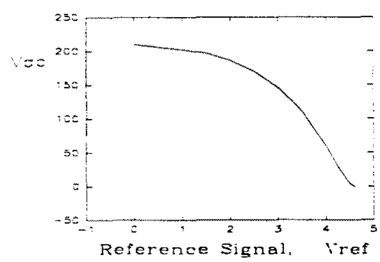

Fig. 5. DC output voltage for different values of reference, V_{ref}.

Fig.6 shows the speed versus reference signal at no load. Fig.7 shows the same at a load current of 1 [A] for both feedback and with out feed back condition The results show both open loop and closed loop control.

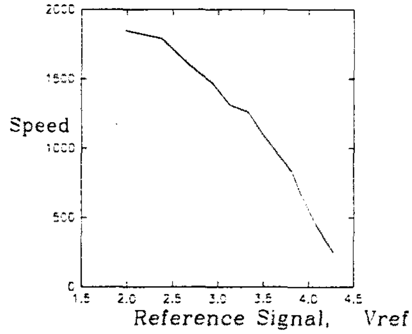

Fig. 6. Speed versus V_{ref} characteristic.

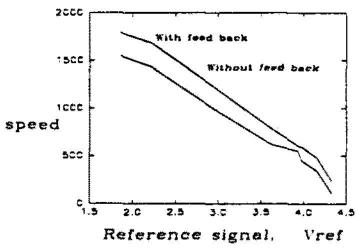

Fig. 7. Speed versus reference signal at a load current of 1.0 amp.

3.2 Microprocessor Control

It was mentioned earlier that the reference signal can be given through microprocessor based software program.

Fig. 8 shows the block diagram of the circuit used to test in a microprocessor based system. Fig.9 shows the signal that was generated by software program. Fig. 10 shows the corresponding speed. It is to be noted here that although 8085 microprocessor was used in the test circuit, but because of the analog control signal, any microprocessor can be used to generate the control signal.

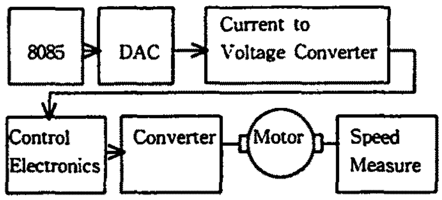

Fig. 8. Block diagram of the microprocessor control scheme.

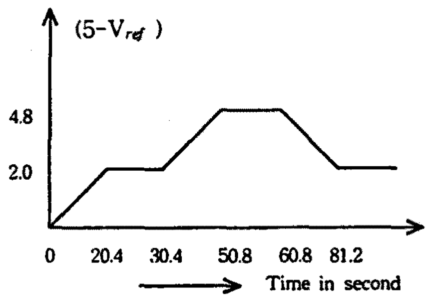

Fig. 9. Signal generated by microprocessor.

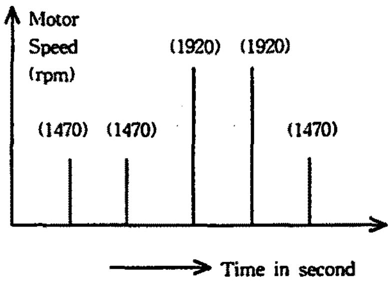

Fig. 10. Motor speed versus time.

4. Other Application Aspect

The following control scheme can be used in an ac voltage stabilizer circuit. The phase controlled converter converts the ac voltage corresponding to a delay signal. The delay signal is controlled by the control circuit in accordance with a feedback signal. If the input is high, the output will also be high. Depending on the new feedback signal the control circuit produces a new delay for the converter, and thereby, decreasing the output. The reverse thing happens if the input voltage is decreased. Hence always stabilized output is obtained. It is to be noted here that although the authors did not carry out this experiment but hold the concept that the indicated circuit should function very well.

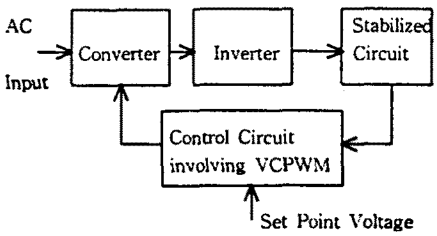

Fig. 11. Block diagram of the probable application of the VCPWM in a stabilizer circuit.

5. Conclusions

The delay time corresponding to an analog signal obtained by the VCPWM is exponential in nature in stead of linear. It is due to the exponential charging and discharging of the capacitor of the timer. The data to be used in the program are digital(in the absence of assembler). But the hardware structure receives only analog signal. So during low level programming, calibration chart suitable for the DAC , is required for adaptation. In fig. 7 the characteristic of the speed versus reference signal without feedback shows some dent at higher values of reference signal. In the neighbourhood of 4.5 [volt] of the reference signal, the VCPWM is very sensitive. So, for a little fluctuation of the reference signal the result changes. So, this dent may be due to the circuit characteristic.

References

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