Power unit controller for RF excited CO_2 laser

S. Messaoud , Guo Zhenhua , Xu Desheng
(National Laboratory of Laser Technology ,HUST ,Wuhan , 430074)

Abstract : In this paper , we describe the design and function , application of the power unit controller for mini RF excited CO_2 laser , pulse width modulation (PWM) is the convenient way to vary the laser average output power from 1 % to 100 % of maximum.

Key words : RF excitation　pulse width modulation (PWM)

RF 激励 CO_2 激光器功率控制器

S 麦啃德　郭振华　许德胜
(华中理工大学激光技术国家重点实验室 ,武汉 ,430074)

摘要: 描述了小型 RF 激励 CO_2 激光器的功率控制器设计、功能和应用 ,根据脉宽调制原理可以方便地把激光功率从 1 %变化到 100 %。

关键词: RF 激励　脉宽调制(PWM)

1　Introduction

The rapid development of RF laser leading to significant application. One of the typical application is marking and cutting , material cutting and marking speed is a function of power. With processing speed directly proportional to laser out put power , for any type of laser , a power unit controller (PUC) must be provided. To effectively control output power of laser , pulse width modulation (PWM) is used to vary the average voltage applied to the RF amplifier[1,2] , which control the RF drive applied to the laser electrodes and is also a convenient way to vary the average output power from 1 % to 100 % of maximum. The laser output follows the modulation control signal with a time constant of 100μs.

In the present paper , we describe the design and function , application of the power unit controller for RF excited CO_2 laser[3]. Synoptic schema of the laser is shown in Figure 1. The oscillator serves the radio-frequency of 40MHz. More information of low - power RF excited CO_2 laser can get from the references [4～6] in china.

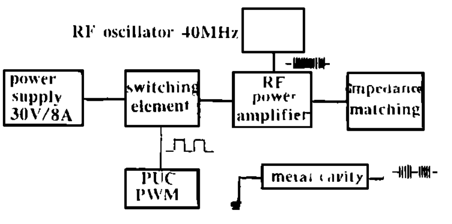

Fig. 1　Synoptic schema of RF excited laser

2　Description of synoptic schema

Synoptic schema of PUC is given in Figure 2. Power supply deliver 15V , 5V and - 5V DC respectively to the circuit. A fusible 0.5A protects the circuit. IC1 is the master clock, either set to 3, 5, 10 and 14kHz with dip switch. The output waveform is approximately square. IC2 is triggered by IC1 and provides for the 1μs duration "tickle signal" required for RF CO_2 laser. The duration of pulse can be adjusted the "tickle" signal is connected to OR gate IC3. The other input to this OR gate is from the variable duty cycle generator. Output from the OR gate goes to J3. It can drive RF CO_2 laser. The triangular signal delivered by master clock IC1 is then applied to a comparator through buffer IC6. The other input of the comparator is a DC signal corresponding to the selected modes (Man, ANV, Gate). The attenuator is used to attenuate the DC singal from IC7 or IC8 to a range about 2.1V at input of IC5. Whenever, the DC voltage signal exceeds the triangular signal voltage the output of IC5 goes T.T.L high level.

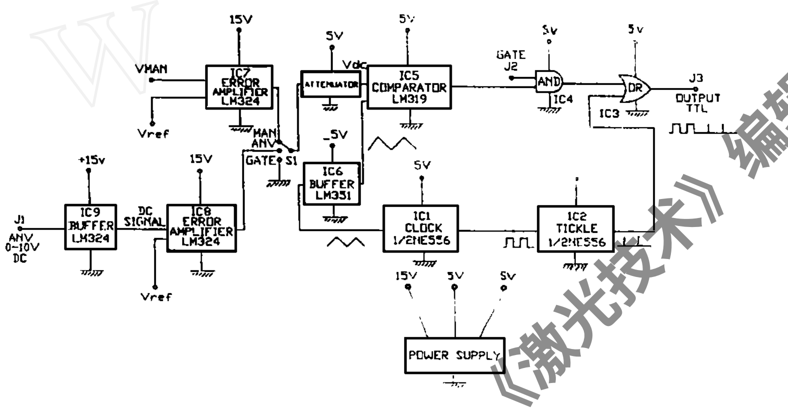

Fig. 2　Synoptic schema of PUC

In the ANV mode, the external control voltage of 0 ~ 10V DC is buffered by IC9 to generate a high impedance input and is then applied to the input error amplifier IC8 which compares control voltage signal to fixed reference voltage. The error is amplified and fed into the input of comparator. In the Man-mode, the error amplifier compares the variation of manual voltage to a fixed reference voltage. Variation of modulation waveform with time is given in Figure 3, a: signal delivered from master clock IC1; b: triangular signal and DC signal from IC7 or IC8 applied to the input of comparator IC5; c: modulation waveform from the output comparator IC5 (duty cycle 25 %); d: modulation waveform from the output comparator IC5 (duty cycle 75 %).

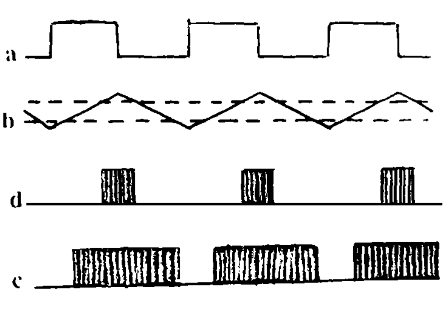

Fig. 3　Variation of modulation waveform with the time

Gate function, the and gate IC4 allows gating of all operating modes with external T.T.L signal that is connected to J2.

3　Experimental result

Using the All-metal CO_2 laser mading by ourselve here, measurement of out put laser power have been made for a variety of values of duty cycle and variety of values of DC control voltage with control frequency (f_c) fixed. The results are shown in Figure 5. The power measurement were made with a laser power meter (power wizard^{TM} 250) and RF power under near perfect impedance matching condition. For duty cycle greather than 50 %, water cooling is strongly recommended. The schematic diagram of the experimental is given in Figure 4.

Figure 5a shows laser output power vary proportionally with duty cycle and Figure 5b shows the variation of output power with DC control voltage, the power is proportional to voltage applied, and rising to maximum 13W and still constant. In the other hand, we have got the similar results when $f_c = 10$kHz.

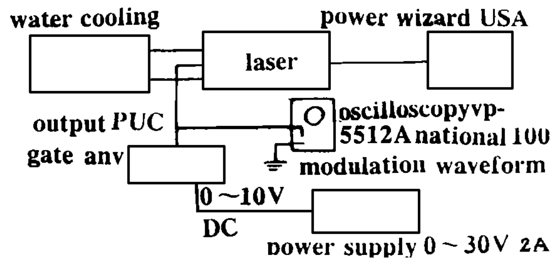

Fig. 4 Schematic diagram of the experimental

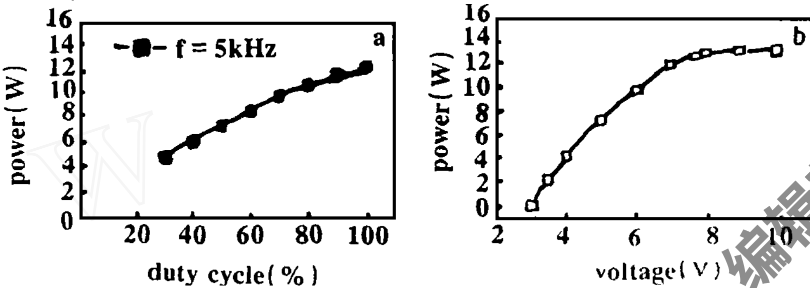

Fig. 5 Dependence of output power on duty cycle and DC control voltage

a —variation of output power with duty cycle at $f_c = 5$kHz (manual mode)

b —variation of output power with DC control voltage (ANV mode) at $f_c = 5$kHz

4 Conclusion

The PUC control laser average power by providing a variable duty cycle 5kHz signal to the laser. Control is from 1% to 100% of maximum. The manually or remotely set power level can be gated by an external T. T. L signal. The controller also provide tickle level that keeps the plasma preionized to achieve fastest possible response. For typical applications of the laser for example as marking or cutting[4,5], an external laser PUC is required. The PUC has been designed to provide necessary control of the laser output from a remote source. The power unit controller should be connected between the laser and the marking head as shown in Figure 6.

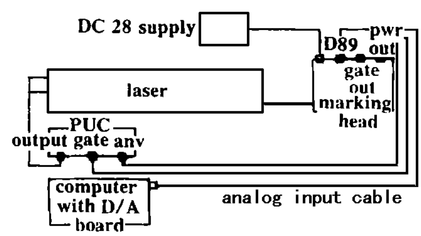

Fig. 6 PUC interconnection diagram

References

1 Ang S S. Power switching converters. USA, New York, 1995

2 Coughlin R F, Driscoll F. Operational amplifiers and linear integrated circuits. USA, New Jersey, 1987

3 Guo Zh H. Mini RF excited CO_2 laser (Authenticated). China, HUST, 1996

4 王又青,郭振华,黄松珏. 激光技术, 1994;18(6):240～243

5 王又青,郭振华,卢益民 *et al*. 激光技术, 1995;19(5):306～308

6 郭振华,王又青,卢益民 *et al*. 激光技术, 1995;19(5):267～270

7 兰戈,赵刚,屈乾华 *et al*. 激光技术, 1993;17(2):90～92

8 刘晓东,胡兵,何云贵. 激光技术, 1998;22(5):300～302

9 赵侠,段军,阮绍骏. 激光技术, 1998;22(2):91～93

* * *

作者简介:S. Messaoud, male, born in 17.04.1962. Graduated from Houari Boumediene University of Science and Technology as an Electronic Engineer. 1990～1995. Worked in the Research Centre of Advanced Technology, Algeria. 1995～1998. Master student in Huazhong University of Science and Technology, China. Research field: Laser Technology and applications.

收稿日期:1998-12-01