



Design And Implementation of Microcontroller Based Curing Light Control of Dental System.

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Abstract:-

In this paper, a microcontroller-based electronic circuit have been designed and implemented for dental curing system using **8-bit MCS-51** microcontroller. Also a new control card is designed while considering advantages of microcontroller systems the time of curing was controlled automatically by preset values which were input from a push-button switch. An ignition based on **PWM** technique was used to reduce the high starting current needed for the halogen lamp. This paper and through the test result will show a good performance of the proposed system.

Keywords: microcontroller, dental curing system, electronic circuit.

1.Introduction

The curing process in dental system is cured depending on the material used between 10 and 60 second in step of 10 second using blue beam light from a light source. The existing types of cards utilize analogue-controlled time features like time control and light intensity control. Some disadvantages of these systems can be stated as complexity, low reliability, high cost and big size. This control cards consist of several circuit components, thus can be fairly complex and clumsy. These control cards are mounted on two or more separate boards because they just do not fit in a single board.

The new design is compared with other existing system; the major advantages of the new designed system are the following the small size of the system, programmable, simple, reliable, and low cost. The 12V, 75

watt halogen lamp, the source of the light is controlled by a power transistor with a PWM mode provided by the microcontroller. By using this technique, the starting current needed for the lamp is reducing. Consequently, the desired curing process for the dental system is obtained. The new control card can be also fit in a single board because there are a few circuits used by the design, which reduce the cost and the noise level during its operation.

2.The System Characteristics

The designed system is a light curing unit for interiorly polymerization of dental materials that can be shown in Fig(1). The system is a hand-held, corded. The visible light polymerization system consist of a pistol-style hand piece attached via a 1-m cord to the power unit and the power unit contains a

built-in digital controller and D.C power supply. The activation ON/OFF control exposure time selection switches and seven-segment display are conveniently located on the power unit. The hand piece comes with quartz-halogen lamp and a 10-mm curved curing wand. a thermister was used near the halogen lamp which will interrupt the microcontroller when the temperature of the lamp goes to a high value, Then the microcontroller will turn the fan on to minimize unnecessary fan operation and noise.

3.The System Implementation

Among curing light control system, one of the most reliable ones is the microcontroller type. the microcontroller and halogen lamp power supply designed for positive voltage of 5V and 12V using LM7805S and the power LM317 voltage regulators respectively, as shown in Fig.(2). Selection of resistors R_1 and R_2 allow the setting of the output to any desired voltage over the adjustment range (1.2 to 37 V). the output voltage desired can be calculated using :

$$V_o = V_{ref} \left(1 + \frac{R_2}{R_1}\right) + I_{adj}R_2$$

with typical values of $V_{ref}=1.25$ V and $I_{adj}=100$ μ A.

For a 12 V, the values of the resistors R_1 (which act as a current sensor) and R_2 are 220 Ω and 2K Ω respectively.

The control card circuit diagram is shown in Fig (3). Microcontrollers require one or more power supply voltages, these voltage values should be kept in the 5% margin of operation limits.

In order to display a 2-digit decimal number indicate the time of curing in seconds, a seven-segment display units is used. Also we used the 7447 driver/converter to prevent the vibration of the LEDs. Each display has a common cathode and controlled by a single transistor driven from the microcontroller.

A heat sensor, the thermister, have been putted near the halogen lamp which runs as a switch, when the lamp temperature rise above

75 $^{\circ}$ c the thermister will contact enabling the interrupt of the microcontroller, the microcontroller will stop its convent work, turning OFF the lamp and turn ON the fan is in order to cool the system. This is an important feature provided by the new design using microcontroller, which will protect the system from damage and make the work safely.

Three push button switches are provided with the system located in the front panel two of them are used to select the required time for curing. By pressing the increment switch the seven segments will display the time in seconds, each press will increase the time 10-second. The decrement switch is opposite to the increment one. The start switch is press when the required time is selected, this switch shall run the halogen lamp.

4.The Software Solution

In this work a problem has been occur during the test of the system, when the power is turn on the system work normally, once the halogen lamp is turn on, the microcontroller is reset. the reason for this case is that the lamp when work in its rating consuming a current of 6 ampere, when it is worm, but the starting current is much more than this by two or three times, thus the D.C. voltage of the power supply will drop very fast causing restart of the microcontroller. Many solutions to this problem was introduce, one of these solutions is to use a power supply dedicated for the halogen lamp, but this will lead to make the system size bigger with high cost.

A pulse width modulation PWM technique is used to solve this problem by using the benefit of microcontroller. A worm software subroutine was built; by this a frequency of 4.9 MHz (2040 μ sec.) was produced. For the first period a pulse of ON about 8 μ sec. width is given to the halogen lamp then the lamp is turn OFF for a period of 2032 μ sec, as shown in Fig (ξ -a-), for this pulse the D.C. supply voltage will not drop. In the next period a pulse of 16 μ sec. is ON and 2024 μ sec OFF and so on. This technique would continue for 0.5 sec, after this time the voltage input to the transistor of the lamp is

stay ON for the required time of curing 10, 20, 30,.. sec. as shown in Fig.(4-a-).

5.The test result

By using this technique the duty cycle is changing linearly by a figure of 0.4 % .where the duty cycle is

$$duty\ cycle = \frac{T_{on}}{T_{on} + T_{off}}$$

In the first period the duty cycle is 0.4% and increasing each cycle by this value. By this the lamp will worm in about 0.5 sec. Fig (4-b-) shows the current rising through the worm time and then stay at steady state for the rest time. Fig.(4) explain the starting current without using the PWM technique, these result was obtained practically using digital storage oscilloscope.

6.The Conclusions

The four most important results of this study for the purpose of controlling of light curing in dental system are

Usage of microcontroller in the control card, the small size of the system, the full reliability of the control card comparing to its relatives, using the new software solution for

the hardware problem. The control card of the early equipment is semi-mechanical. Timing values are input from potentiometer. The most sophisticated control card that is in use is designed with the digital design techniques.

In this designed system a smaller amount of the circuit component is used and all of them are placed on one card.

7.References

- 1) Metin Kapidere, Serdar Muldur, and Inan Guler, *control of dental prosthesis system with microcontroller*, jornal of medical system, vol. 24, NO 2, 2000.
- 2) Cyril W. Lander, *Power Electronic*, Second edition, McGraw-Hill, 1987.
- 3) Mike James, *Microcontroller Cookbook*, prentice hall, 1997.
- 4) Gene f. Franklin, David Powell and Michael Workman, *Digital Control of Dynamic System*, Third Edition , Prentice Hall, 1998.
- 5) Pei An, *PC Interfacing using Centronic, RS232 and Game Ports*,Newnes, 1998

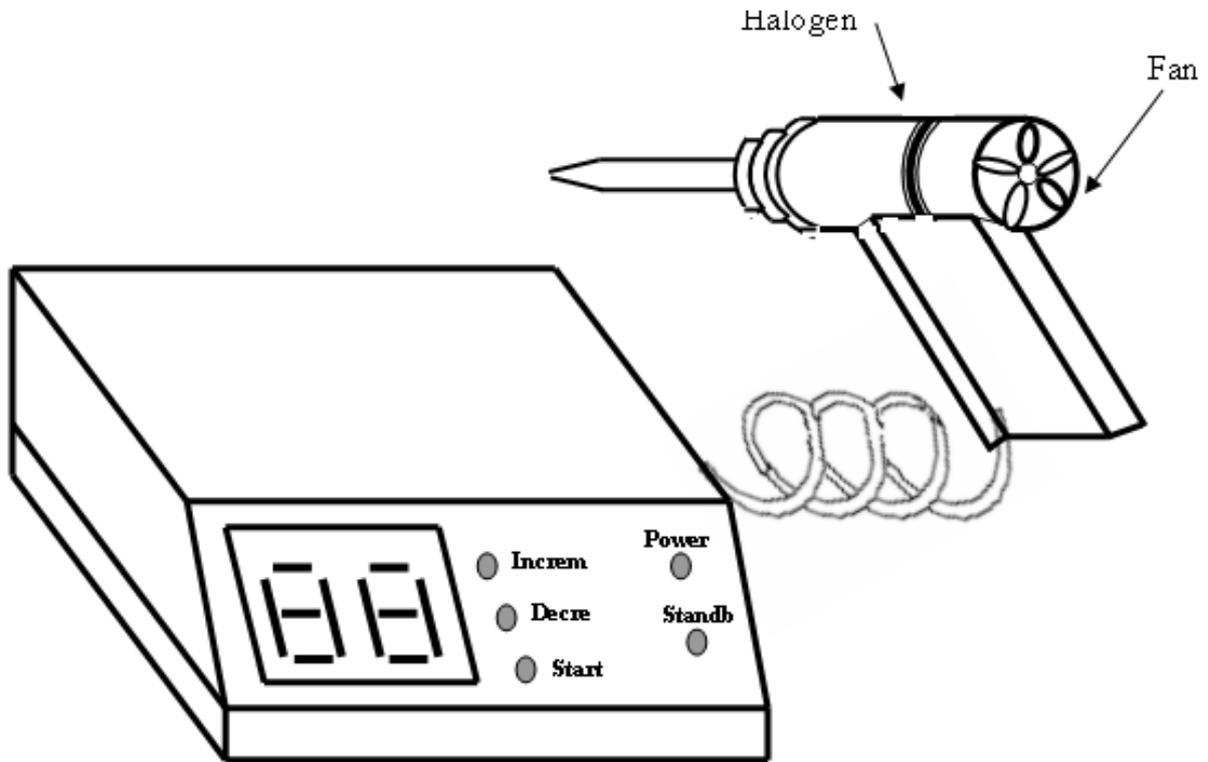
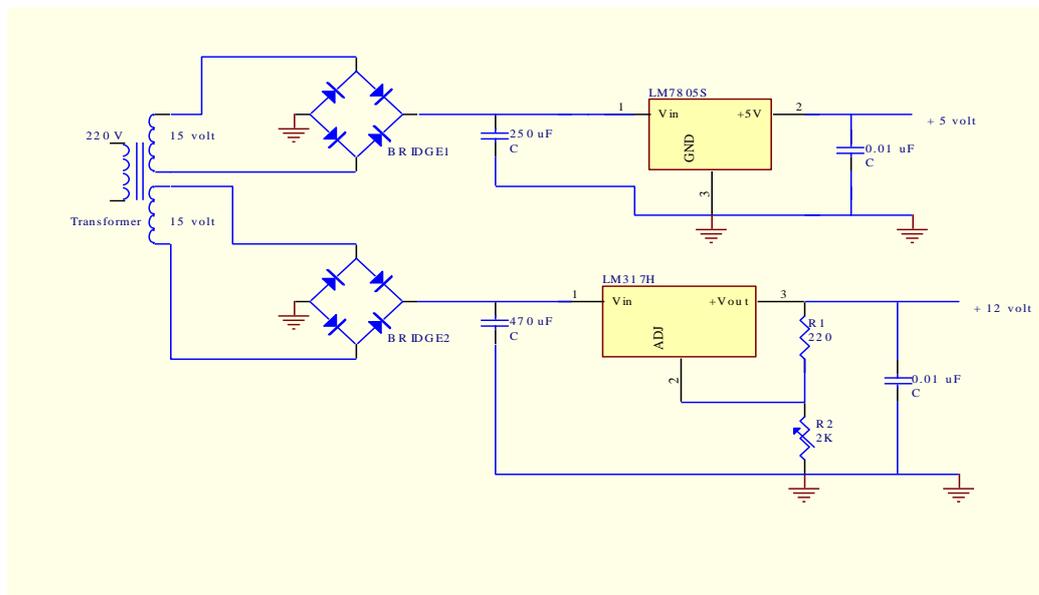
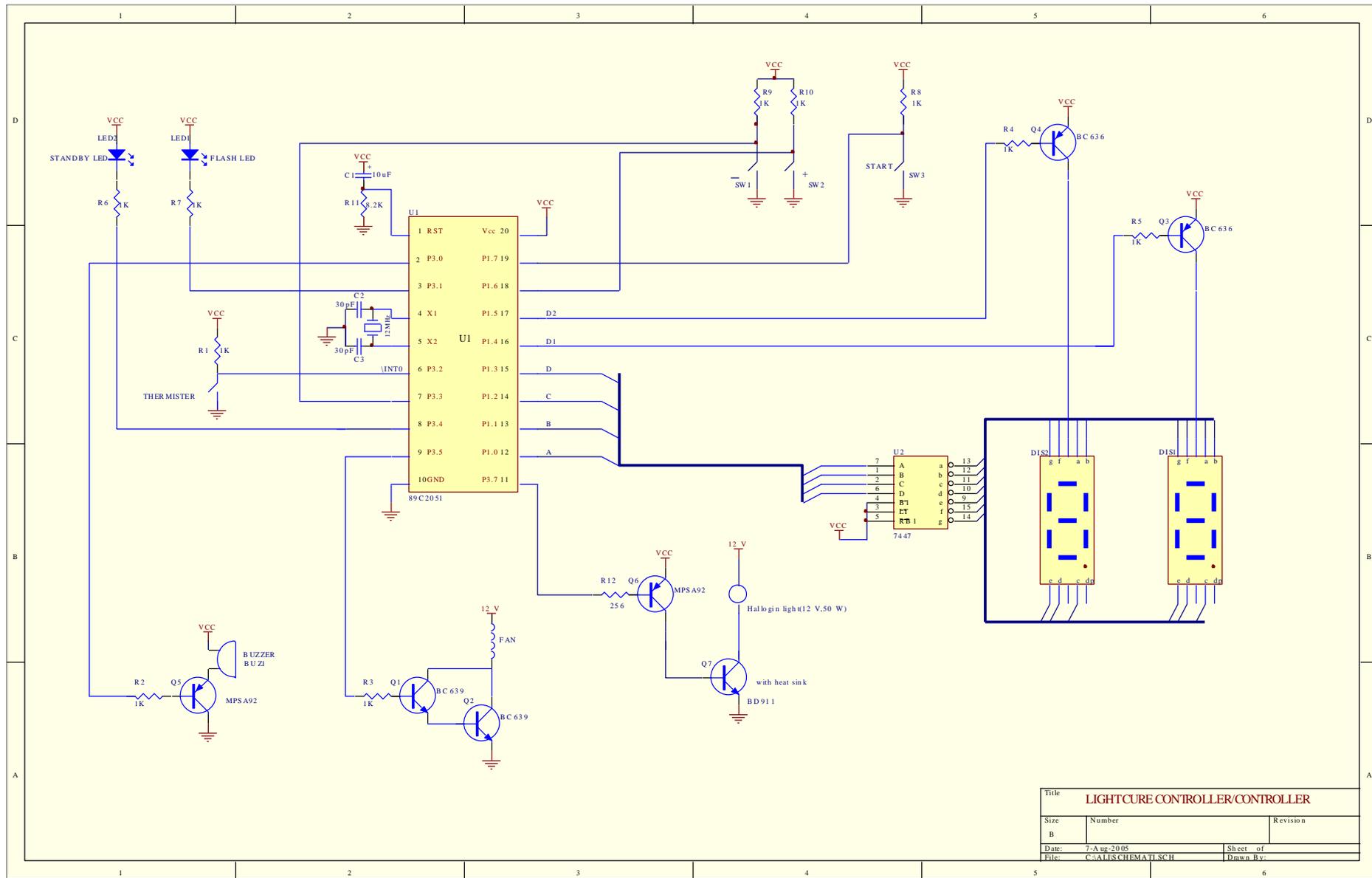


Fig (1) Schematic diagram of the proposed system

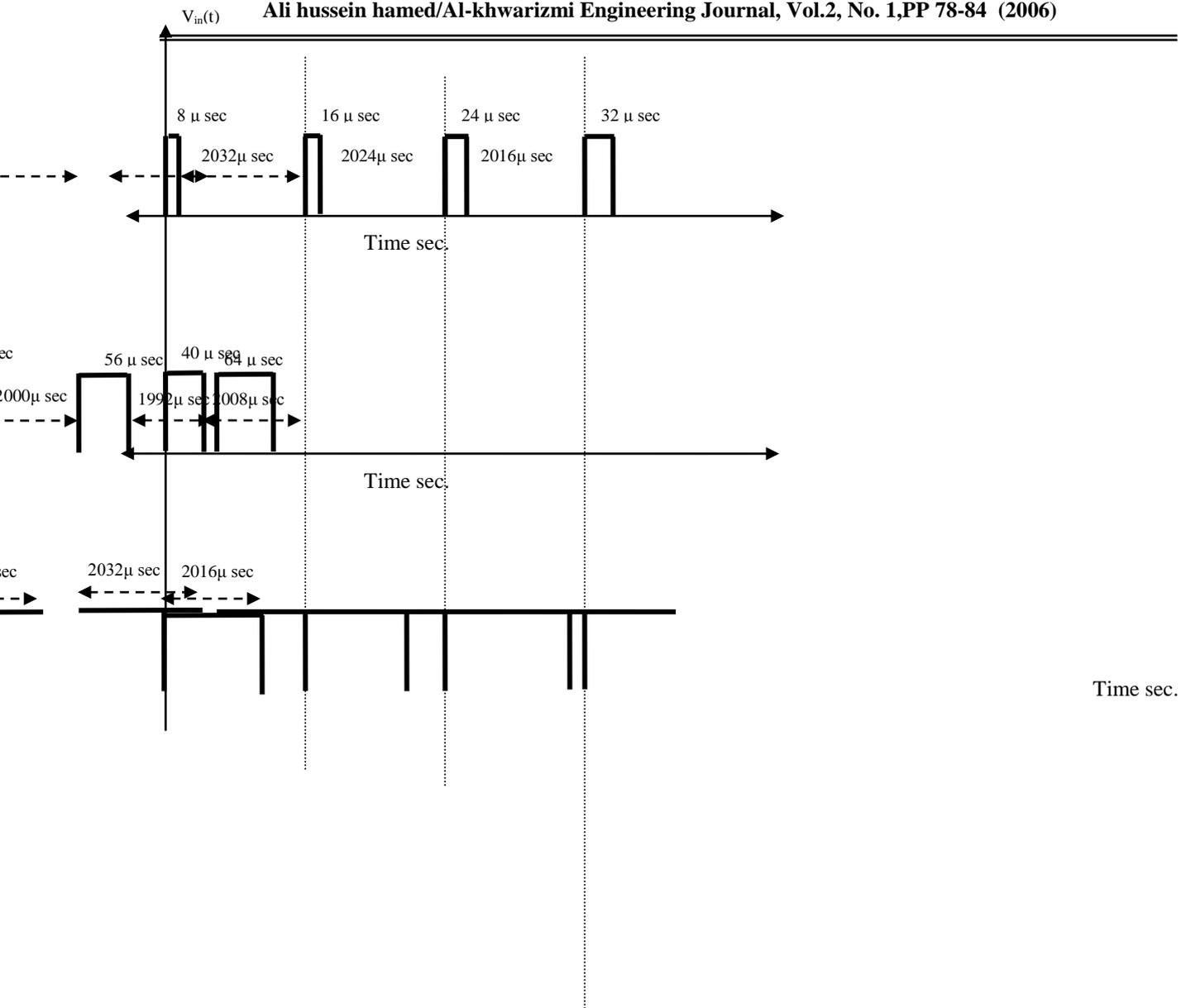


Fig(2) Schematic digram of the designed power supply



Title		
LIGHT CURE CONTROLLER/CONTROLLER		
Size	Number	Revision
B		
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Fig (3) Circuit diagram of the control card.



Time sec.

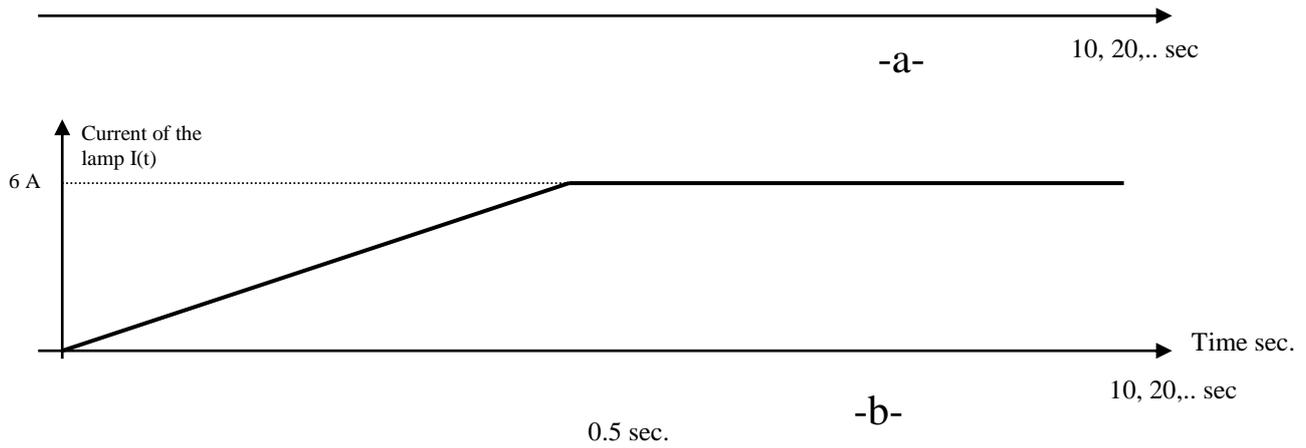


Fig (4) Schematic diagram of the PWM technique. a) The voltage input to the base of the power transistor driving the lamp. b) The current of the lamp during the warm and steady state.

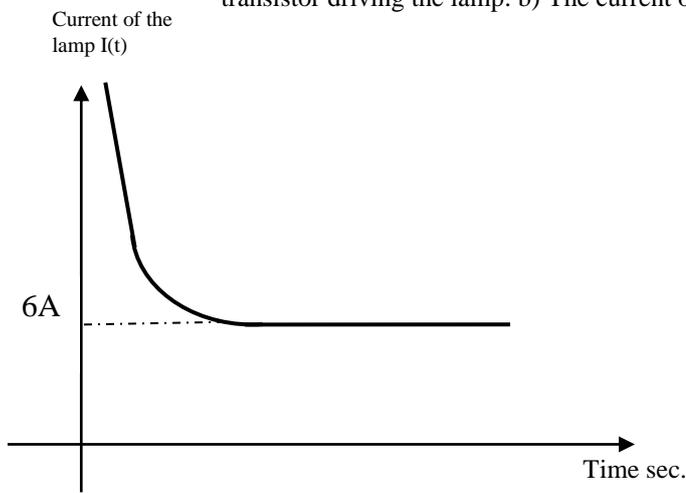


Fig (5) The starting current of the lamp without PWM technique.

تصميم و بناء دائرة معالج دقيق للسيطرة على منظومة التجفيف الضوي للأسنان

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الخلاصة:

في هذا البحث تم تصميم و بناء دائرة الكترونية باستعمال المسيطر الدقيق تستخدم لنظام تجفيف حشوة الاسنان. تم استحداث دائرة جديدة من خلال الاستفادة من فوائد المسيطر الدقيق. تمت السيطرة على الوقت المطلوب للتجفيف من خلال قيم تعطى الي المسيطر مسبقا باستعمال مفاتيح الضغطة. تم ايقاد مصباح الهلوجين المستعمل في التجفيف بطريقة تضمن عرض النبضة وذلك للتقليل من تيار البدء العالي الذي يحتاجه المصباح لكي يعمل. هذا البحث و من خلال نتائج الفحص بين أداء جيدا للمنظومة المقترحة.