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# The Design of High Power Pulsed Laser Power Protection Circuit

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## Abstract

This article in view of the domestic medical long pulse xenon lamp power supply protection in the field of design has carried on the design of the circuit. Analyzed IGBT flowed over voltage protection and over flow pressure protection system, expounds the circuit of IGBT driving module EXB841 principle and some problems with the protection of the existing features, targeted improvement measures are put forward to solve the high power laser driver common surge shock and constant current power supply problems. The experimental results show that high stable output current, and the surge was well be suppressed.

## Keywords

IGBT, Driver module, Protection circuit.

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## 1. Introduction

Laser power supply must have a very high reliability. It needs to be able to run for a long time without fail, in continuous pulse condition can show the good performance. IGBT often face such as more than limit, qing column effect, the transient thermal over-current and so on. Therefore, reasonable and effective protection circuit of voltage, current detection, was carried out on the laser power supply is necessary to protect. This paper mainly introduces the long pulse xenon lamp power supply, IGBT over-current, over-voltage protection circuit and systems of the protection circuit design.

## 2. IGBT and its driver circuit

IGBT drive circuit has strict requirements, IGBT manufacturers in order to solve the problem of the reliability of IGBT, production has special IGBT driver module, these special driving circuit of strong anti-jamming capability, high degree of integration, speed, perfect protection function, can realize optimal drive of IGBT. At present, in many companies the IGBT driver module, with Japan's Fuji EXB841 is the most representative of the company. EXB841 is among the first to enter the driver module, mature technology, wide application. Good consistency, the chip circuit parameters and flow detection and flow signal output, flow slowly shut off function, can prevent to normal driving speed to cut off the flow, produce high collector voltage spike damage of IGBT, the driver delay no more than 1, the highest working frequency can reach 50, pressure under 2500 ac. But a piece of EXB841 can only drive a IGBT, and the need to provide separate floating power supply, increase the using cost reduces the reliability. In the design of this article by using EXB841 as IGBT driving circuit can basically meet the over-current protection of IGBT.

Long pulse laser power supply using IGBT as the switch element. In this paper, the design adopts Japan Fuji's EXB841 as its drive circuit. Figure 1 for EXB841 working principle diagram. It is based on IGBT over-current use the CE inter electrode voltage to determine whether the size of the flow and protection. Its process is: when the IGBT is open, the  $U_{ce}$  is too large, makes  $V_{d2}$  cut-off, point A higher voltage, breakdown,  $V_{w2}$ ,  $V_{t3}$  conduction, C4 by R3 discharge voltage by point B. Gradually

decline, so that IGBT U<sub>ce</sub> voltage drop between the CE, realize slow turn-off, complete EXB841 protection of IGBT. Usually IGBT in the pressure drop through conduction when the rated current of 3.5 V, when the U<sub>ce</sub> = 7.5 V, IGBT has severely over current, the current is about 2 ~ 3 times the rated current. Obviously, in the case of IGBT over-current serious, even if implemented protection EXB841, which have a bad effect on the life of the IGBT is still. Because of the IGBT has a forward biased the often overload zone, in the case of IGBT forward biased, it flow number is limited, the greater the current, the less number of times.

In the case of multiple overload, IGBT will be damaged due to internal fatigue effect. Therefore, in order to implement more reliable protection for IGBT,

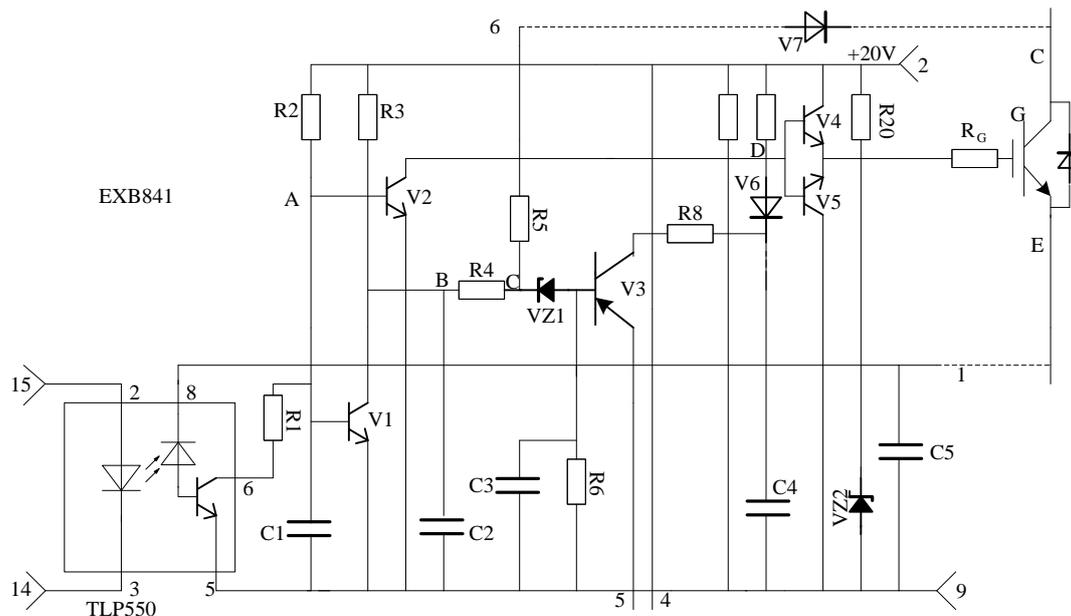


Figure 1 EXB841 working principle diagram

Extend the service life of IGBT, need in mild shed for their own protection. In general, when the U<sub>ce</sub> > 3.5V, has more than rated current, the over-current protection should be implemented. Can in Vd2 with IGBT C inter electrode cross-dressing a regulator tube, if the voltage value of the voltage regulator tube for U<sub>cw</sub>, when the over-current protection of IGBT turn-on pressure drop: U<sub>ce</sub> = 13 - 0.5 \* U<sub>cw</sub> - 5 = 7.5 \* U<sub>cw</sub>, therefore, the value of the voltage regulator tube has, the greater the is, the smaller the U<sub>ce</sub> IGBT also allows the flow of current value is smaller. In practical application, we successfully by using the method of series voltage regulator tube IGBT current limit to 200 a, circuit is simple, stable and reliable work, give full play to the function of EXB841 internal slowly shut off.

### 3. IGBT over-current protection

IGBT (insulated gate bipolar transistor) of damage is usually due to pipe through the instantaneous large current, make the tube core is rapidly growing, and the heat in a short period of time can't send out, the tube core is burn out. Therefore, IGBT inverter cannot use fuse current protection, the fuse is to use power to fuse, too slow for IGBT protection. So need to design some high speed response circuit to protect IGBT.

This key is used to protect a half bridge inverter circuit of two power tube, in some unexpected circumstances, bridge the two tubes at the same time conduction on the road, which leads to two power tube directly concatenated in high voltage circuit, the current in the circuit will be very big and damage the power tube. In this design USES the current sampling test loop in the total current, when more than a certain value protection circuit action, blockade of inverter. The specific circuit is shown in figure 2.

Current sampling signal input rectifier filter to the comparator reverse side, the same phase terminal for TL494 output reference voltage, adjust potentiometer to make the power work within the scope of the permit, when the current sampling signal exceeds limit value, the comparator flip sent to the output level of TL494 16 feet, the closed circuit are introduced to blockade the inverter.

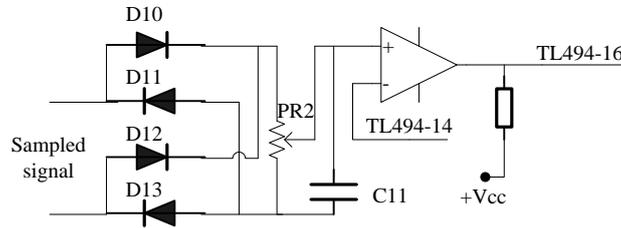


Figure 2 over-current protection circuit

#### 4. Over-voltage protection circuit

Over voltage protection circuit is designed to prevent damage to the capacitor energy storage capacitor charging too much on, and a single discharge energy is too large, to achieve the explosive power of the xenon lamp, and damage the xenon lamp. Circuit shown in figure 3.

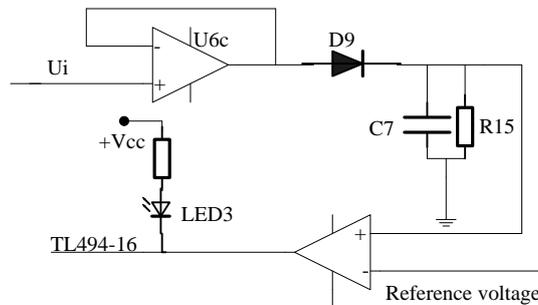


Figure 3 over-voltage protection circuit

The over voltage protection circuit is relatively simple, voltage sampling by the follower input to the inverting comparator, when the sampling signal exceeds limit value, the comparator output high level to 16 feet by the blockade of TL494 circuit of inverter. C7 and R15 filtering network voltage sampling signal of the burr, prevent protection circuit misoperation. LED3 is over voltage instructions.

#### 5. Sampling some protection circuit

Figure 4 is the sampling part of the protection circuit. Sampling the voltage by the current limiting resistor to the comparator + end, reference voltage by the linear optical coupling to - end voltage comparator. When sampling the voltage is greater than the reference voltage, the comparator will output a high voltage causes triode conduction at the same time, will be connected to the transistor level CTL4946 feet and conduction, undercutting voltage 6 foot, make the TL494 doesn't work, so as to achieve the aim of sampling protection.

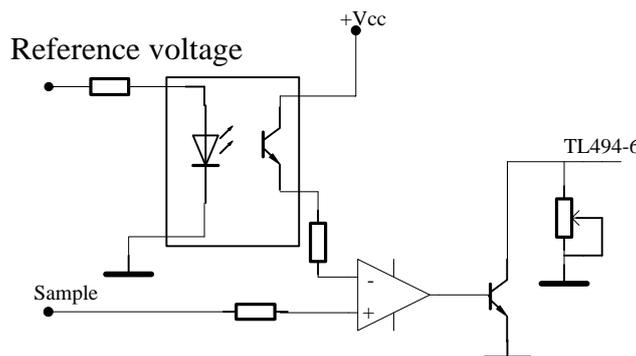


Figure 4 sampling some protection circuit

### 6. Discharge blocking signals and precombustion

Figure 5 is discharge blocking signals and TL494 chip connection diagram 16 feet. By single chip discharge blocking signals through the linear optical coupling, make the inside of the linear optical coupling triode conduction,+15v power supply with triode and current limiting resistor forming circuit, so pull TL494 16 feet of voltage. When no start signal, a + 15 v and TL494 16 feet by diode connection, voltage up to 16 feet, start the inverter to limit TL494.

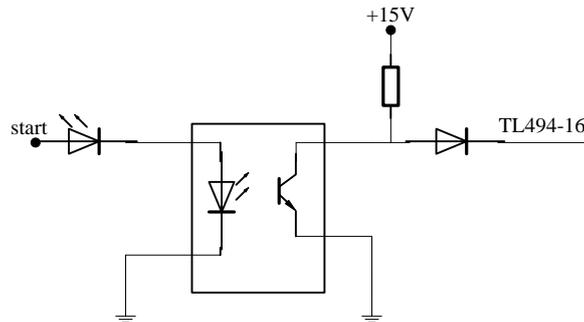


Figure 5 discharge blocking the signal

Figure 6 is precombustion signal connection diagram with TL494 chip 16 feet. By microcontroller precombustion signals through a linear optical coupling, and make the inside of the linear optical coupling triode conduction.+15v power supply with triode and current limiting resistor forming circuit, so as to pull TL494 16 feet of voltage. When no simmer signal, a+15v and TL494 16 feet by diode connection, voltage up to 16 feet, start the inverter to limit TL494.

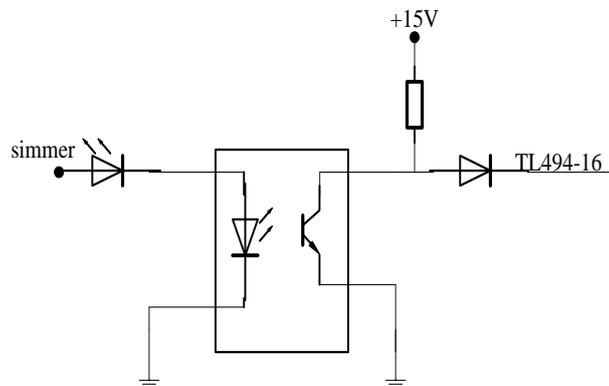


Figure 6 precombustion protection circuit

### 7. Block circuit and protection relay cut-off

Happened when the system through the abnormal situation such as pressure, flow detection circuit and over voltage detection circuit immediately output signal effectively, at this time to ensure the system immediately blockade of inverter. In the system to work normally, the industrial computer block signals should be effectively blocked inverter.

This circuit is to all kinds of signals are integrated, generates a signal block directly control the output of the TL494 control pin, cut off the inverter signals, specific circuit as shown in figure 4. 16 feet of TL494 blockade, consists of the diode "or" door, arbitrary blocking signal for high electricity at ordinary times, 494 to stop working.

Since the pulse xenon lamp power supply for medical hairdressing, so its reliability is especially important. In this thesis is to design a emergency shutdown button, in any state, through the button control relay the pulse xenon lamp power supply system of power supply can be cut off, and shut down the entire power system.

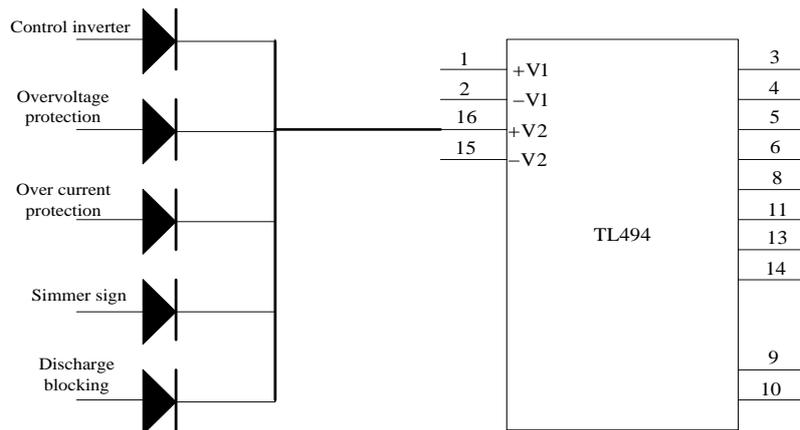


Figure 5 closed circuit

## 8. Conclusion

Experiments show that the protection circuit design, can meet the demand of high power laser protection of xenon lamp power supply. For IGBT (insulated gate bipolar transistor) has significant protective effect. At the same time, in the common abnormal phenomenon such as over-current, over-voltage, can make the laser power supply emergency stop working, and very good to solve the big electric current and voltage to the destruction of the pulse laser power supply.

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