A STUDY ON THE PERFORMANCE OF A DIODE LASER DRIVE CIRCUIT

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ABSTRACT:

A suitable drive circuit for a diode laser (670nm) was designed and constructed. The drive current was designed according to the specification of a real optical fiber communication system. The performance of the constructed drive circuit was tested. The effect of temperature on the output optical power of the diode laser was investigated. The temperature is varied from 15^{0}C-30^{0}C- five degrees for each step. The optimum threshold drive current was detected at 15^{0}C.

ملخص:

تم تصميم وبناء دائرة إلكترونية لغرض تشغيل الثنائي الليزري بناءا على مواصفات الألياف البصرية المستخدمة في الاتصالات. وقد تم اختبار أداء الدائرة وتمت دراسة العلاقة بين تيار الدخل والقدرة الضوئية الخارجة من الثنائي وتأثير درجة الحرارة عليها. كما تم إيجاد حد العتبة المناسب عند درجة الحرارة العادية(درجة حرارة الغرفة).

INTRODUCTION:

The semiconductor diode laser (SDL) has come to dominate the laser field in its technological importance and has become the key element in an increasing number of applications, most notably in optical fiber communication and optical data storage. This success is

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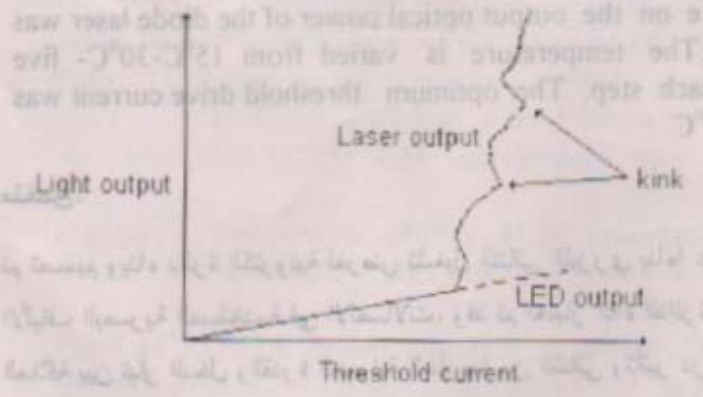
due to the fact that semiconductor lasers are simply pumped by passing a current through them at a voltage (and current) levels that are compatible with those of integrated circuit, so that they can be modulated directly at frequencies in excess at 20 GHz. The important light source is semiconductor injection laser. Semiconductor lasers are diodes that emit coherent light by stimulated emission. They consist of p-n junction inside a slab of semiconductor that is typically less than a millimeter in any dimension. Excitation is provided by current flow through the device, and the cleaved ends of the diode provide the feedback mirrors. It employs a similar mechanism to that of LED, but operates with laser-type stimulated emission, and this produces a different output characteristic. The general relationship between the output optical power against input drive current, is shown in fig(1).



Fig(1)

Schematic relationship between output optical power and input drive current for a typical laser diode.

We can note three features. First, the curve has two distinct sections, one below threshold and one above the threshold. The threshold level is closely related to the structure of the device. Below threshold, the action of the device is similar to that of an LED, and the output has a broad spectral width. Above threshold,

the device operates under stimulated emission and the spectral width is very much reduced. The second notable feature is the steep gradient above threshold. This makes the device very fast, and this speed is exploited in high- speed digital systems. The output nonlinear features, are called kinks.

These kinks which are thought to result from slight changes in current path through the active region of the device. By using a stripe configuration it is possible to eliminate them.

In telecommunication the choice is the laser diode as the source because of the following:

1- Its configuration is compatible with launching the light into the optical fiber. Ideally light output should be highly directional, so that couples sufficient optical power, which is useful to overcome the attenuation in the fiber.

2-Linear light – current curve over a wide current range.

3-Emit light at wavelength where fiber has very low loss and low dispersion.

4-It has a very narrow spectral width.

This work is devoted to the performance characteristics of semiconductor lasers. In addition, some discussion is provided on fabrication and designation of diode laser drive circuit.

EXPERIMENTAL PROCEDURE:

The main components of the system are the diode laser 670 nm, the PMMA optical fiber and a PIN photodetector. The specification of the diode laser is shown in table (1). In the present work transistors switching current developed for optical fiber telecommunication system was employed.

TABLE (1) THE SPECIFICATIONS OF THE DIODE LASER

Manufacture No.	2N 6105
Type	PNP
Operating voltage	65 mV
Operating current	64 mA
frequency	20 MHz

The designed circuit is shown in figure (2). This circuit is capable of producing pulses as short as 10ns at a pulse repetition rate above 100khz.

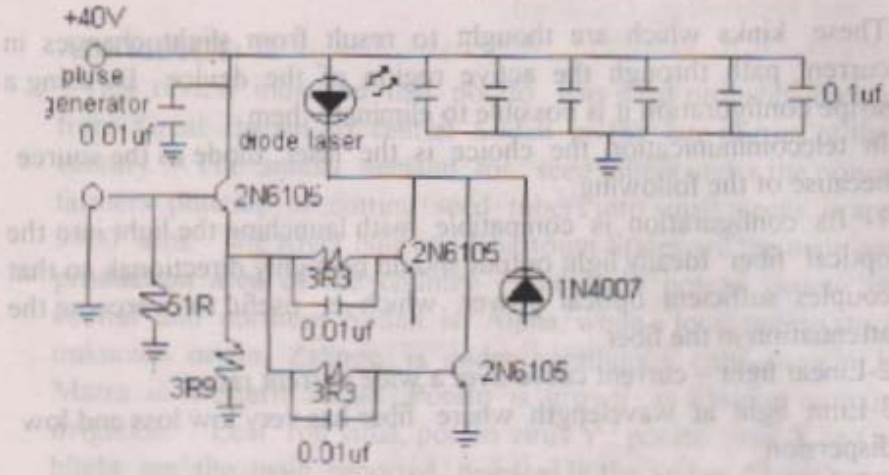


Fig (2)

A transistor switching circuit developed for optical Fiber telecommunication application

The circuit components could be specified as follows. Two capacitors (0.2 μf-0.01 μF) were supplied by Rs company.

Several resistances are employed (two resistors3-3Ω with power 5W-one resistor 3-9 Ω with 3W-one resistance 51 Ω with 3.)

A 1N4007 diode is used. A PNP transistor of (65mV-64mA-20MHz) is used for the operating current and frequency respectively.

The temperature should be controlled on the semiconductor diode laser to set a suitable operation term thus the diode laser is connected with athermalinemic cooler drive (Melles Girot 06 DTC 101 with AD 590/592 sensor).

RESULTS AND DISCUSSION:

The results showed that the output power as function of the drive current depend on the temperature investigated. The temperature is varied from 10°C to 25°C, in steps of 5°C.

First of all, the behaviour of the diode laser at room temperature was studied. Fig (3) represents the output optical power of the diode laser as a function of the input drive current. It is clear that the relation is linear because the output power increases as the drive current increases. This curve shows that the diode laser acts as a light emitting diode at low drive current until it reaches a certain value, which is called the threshold drive current (48 mA). After threshold current the diode laser lases.

The output power increases with a critical value of the current, so the relation between the output power and the input drive current is not linear.

Fig (4) shows the output power as a function of the input drive current at different temperatures. It seems that the output characteristics of the diode laser are strongly dependent on the operating temperature where the output power decreases when the operating temperature increases. There is an obvious increment in the threshold current at increasing the temperature. However, the behaviour of the curve could be changed when the operating temperature is varied.

CONCLUSION:

The performance of the diode laser depends mainly on the drive current. The relation between the optical output power and the input drive current is nonlinear.

The nonlinear is due to the diode laser emitting a coherent light after the threshold current.

The operating temperature affects the output characteristics of the diode laser. It was observed that there was an obvious increment in the threshold current when the operating temperature was increased.

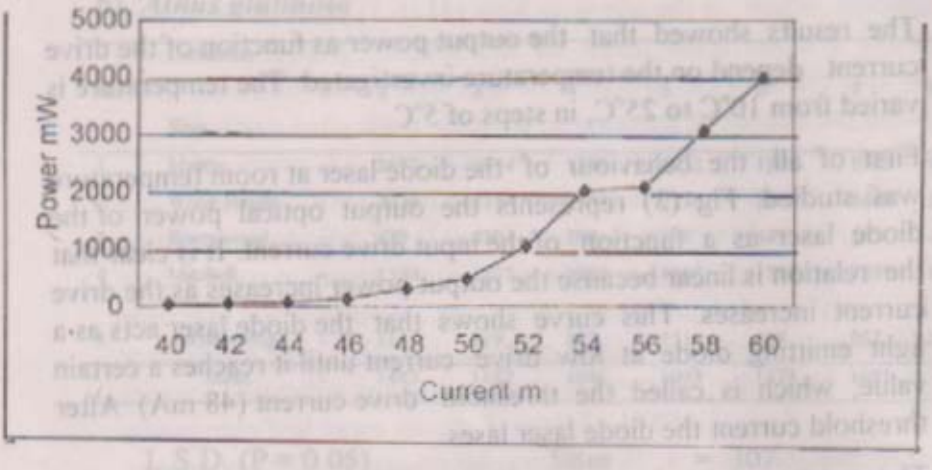


FIG (3) : RELATION BETWEEN THE POWER OUTPUT & THE INPUT DRIVE CURRENT AT ROOM TEMPERATURE

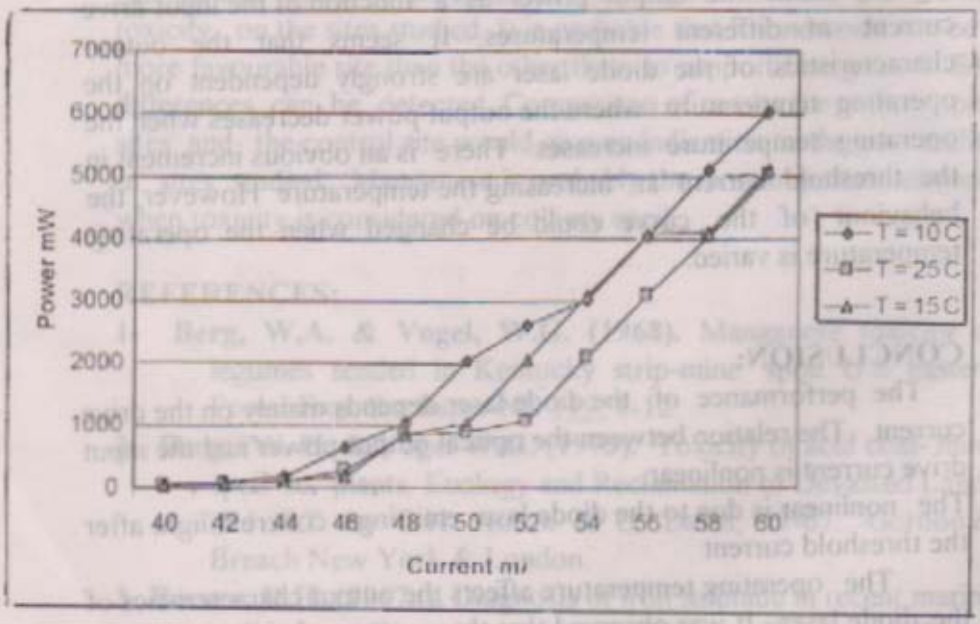


FIG (4) : OUTPUT POWER AS A FUNCTION OF THE INPUT DRIVE CURRENT AT A DIFFERENT TEMPERATURE

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