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(71) Applicant(s):
DenseLight Semiconductors Pte Ltd
(Incorporated in Singapore)
6 Changi North Street 2,
Changi North Industrial Estate,
Singapore 498831, Singapore

(72) Inventor(s):
Hiroshi Nakamura
Subrata Halder
Yisheng He

(74) Agent and/or Address for Service:
Gill Jennings & Every
Broadgate House, 7 Eldon Street,
LONDON, EC2M 7LH, United Kingdom

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(56) Documents Cited:
US 6195371 B **US 5946334 A**
US 5391933 A

(58) Field of Search:
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INT CL[7] **H01S** 3/10 5/026 5/06
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(54) Abstract Title: **Integrated Laser Driver**

(57) An integrated laser module having a laser chip, a transmission line and a driver chip, the laser chip including a laser diode and the driver chip including an emitter follower amplifier, wherein an output of the emitter follower amplifier is coupled to the laser diode via a transmission line.

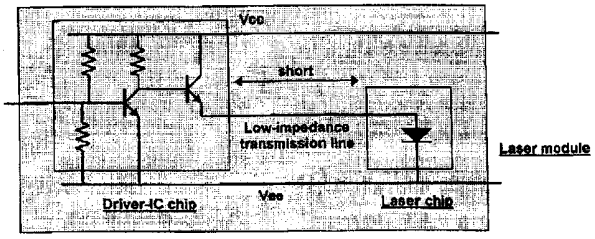

Figure 3

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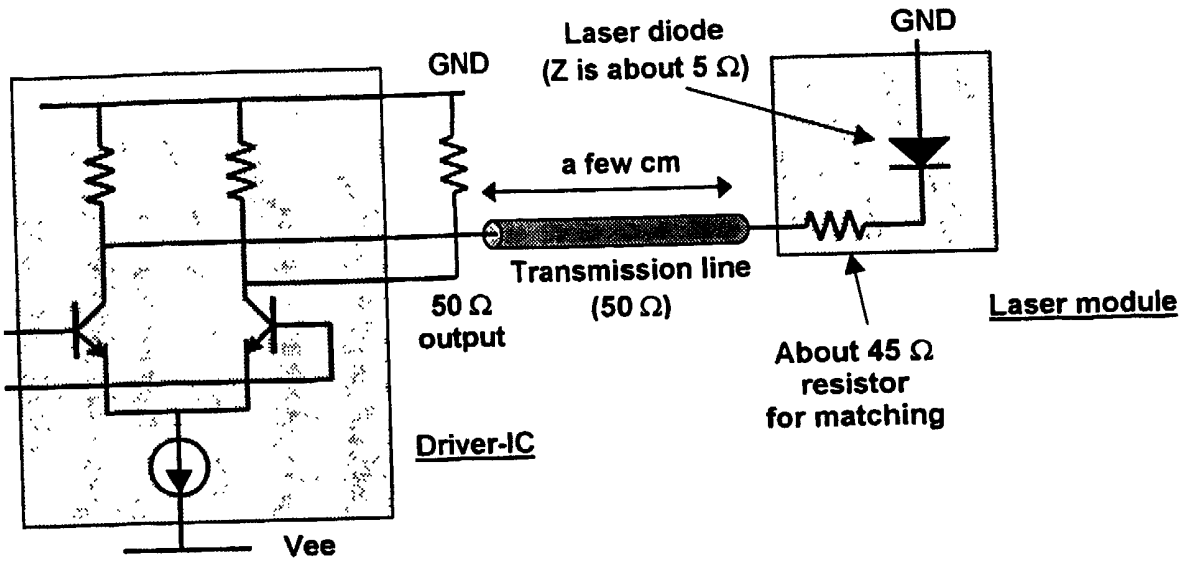

Figure 1

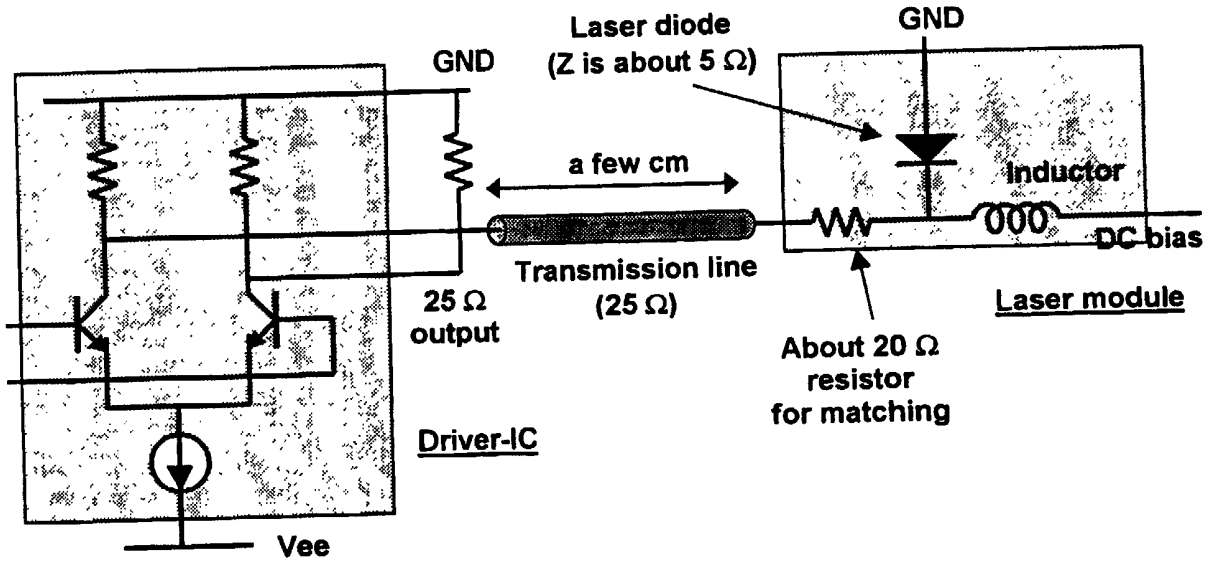

Figure 2

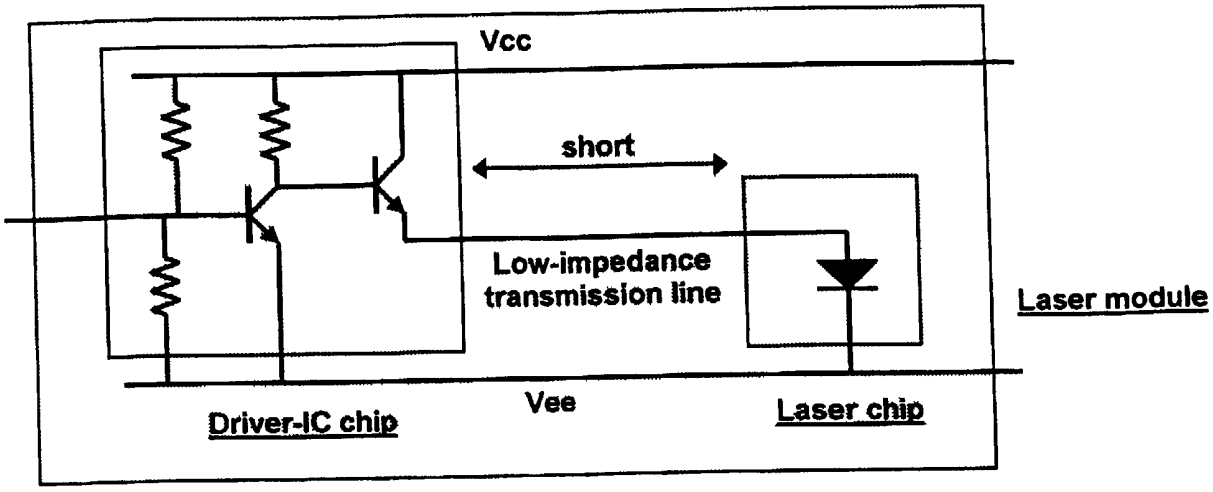
Vcc
short
Low-impedance
transmission line
Laser module
Vee
Driver-IC chip
Laser chip

Figure 3

INTEGRATED LASER DRIVER

Introduction

The modulation of the laser output is imperative to transfer the input electronic data onto the optical carrier for optical fiber transmission Generally, there are two methods of modulation: that is direct modulation by variation of the injection current to the laser diode, and modulation by an external modulator through the electroabsorption or electro-optic effect.

To drive a laser diode by the direct modulation method to a bit rate of 2.5 Gb/s or 10 Gb/s, usually, the configuration shown in Figure 1 is used. In this Figure, only the essential parts of the driver-IC and the laser module are shown. As the RF impedance of the laser diode is very low (about 5Ω or less), another resistor is normally connected in series with it inside the laser module to achieve impedance matching with the 50Ω transmission line.

In some cases (especially for 2.5 Gb/s transmission), a 25Ω impedance is used instead of the 50Ω system. The merit of using an impedance of 25Ω against a value of 50Ω is that of low power consumption. An inductor for DC bias is often used to decrease the voltage of the driver-IC, as shown in Figure 2. However, because of the limited RF performance of the inductor, the application of this configuration to higher transmission speeds like 10 Gb/s is limited. The impedance of 25Ω is almost the lowest limit of line impedance with good RF performance achievable with a long (more than a few cm) transmission line and connectors.

In the configuration used in prior art, the power consumption of the laser driver IC is quite high. This is especially so for the case of 10 Gb/s transmission, where, normally, a 50Ω system is used and an inductor is not used. The reason for this high power consumption is mainly the high voltage drop in the resistor used for impedance matching. In the present invention, a new configuration of a low-power laser driver for high speed direct modulation is proposed.

Proposed New Idea

In the proposed laser driver configuration for low impedance matching and low power consumption, the laser chip and driver-IC chip are placed inside the laser module. Both chips are connected by a short transmission line with low impedance. For example, for a separation of less than 0.5 mm between the two chips, the impedance of the transmission line is around 10Ω or less. Such a low impedance

can be easily realized with a short line created on top of a commonly used substrate.

The output of the driver-IC comes from the emitter of the transistor, as shown in Figure 3 Here, the current of final stage transistor is directly supplied to the laser chip. In the Figure, the preceding stages of the driver IC are also shown for better understanding, but the configuration in the preceding stages is not limited to the example shown.

The operation of the proposed laser driver module can be explained in the following. We assume that the laser bias current for high speed direct modulation is between 20 mA to 60 mA (the average is 40 mA), and the voltage drop is 1.3 V for the 20 mA drive and 1.5V for 60mA drive. In this case, the differential resistance is 5Ω (given by (1.5-1.3)/(0.06-0.02)), and the RF impedance around the bias point is also about 5Ω. This circuit is operational at a speed of 10 Gb/s at a supply voltage (V_{cc}) of 3 V using a transistor with an f_T of 70 GHz.

The current consumption for the preceding stage can be estimated to be about 20 mA. Hence, the total power consumption of the driver and laser chips is estimated to be 180 mW (given by 3 V x (20 mA + 40 mA)). This value of total power consumption for the entire laser module of driver IC and laser diode is very much lower than that achievable in the prior art configuration.

The laser driver and laser diode are connected by a short low-impedance transmission line. This line impedance is close to the output impedance of the laser driver as well as the impedance of the laser diode. Consequently, no significant reflection occurs between the two chips, and thus a good waveform of the optical output is achieved.

In summary, the proposed invention leads to a much reduced total power consumption of the laser driver and laser diode. When properly designed, the novel configuration can result in a reduction of the power consumption to one tenth of that realized in the prior art. This performance of low power consumption is extremely beneficial for high density integration of laser modules, which is often required for DWDM application.

CLAIMS

1. An integrated laser module having a laser chip, a transmission line and a driver chip, the laser chip including a laser diode and the driver chip including an emitter follower amplifier, wherein an output of the emitter follower amplifier is coupled to the laser diode via a transmission line.

2. A module according to claim 1, wherein the module draws less than 200mW in power.

3. A module according to claim 1 or claim 2, wherein the transmission line has an impedance of less than or equal to 10 ohms.

4. A module according to claims 1, 2 or 3, wherein the impedance of the transmission line substantially equals the impedance of the laser chip, thereby reducing unwanted reflection.

5. A module according to any one of the preceding claims, wherein the transmission line has a length of less than a millimetre.

INVESTOR IN PEOPLE

Application No: GB 0206480.6
Claims searched: all

Examiner: Claire Williams
Date of search: 14 November 2003

Patents Act 1977 : Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance	
X	1	US 5946334	(Ema et al) see abstract, Figure 15, and column 37 line 47 to column 38 to line 37.
X	1	US 6195371 B1	(Haneda et al) see abstract, Figure 4 and column 7 line 53 to column 8 line 22.
X	1	US 5391933	(Rein) see abstract and column 4 lines 26 to 41

Categories

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC[V]

H1C (CEA)

Worldwide search of patent documents classified in the following areas of the IPC[7]

H01S (3/10, 5/026, 5/06)

The following online and other databases have been used in the preparation of this search report:

EPODOC, JAPIO, WPI, TXTE