John Smith
Data and Fiber Optic Communications Laboratory ECT281LA

For: Sr. Professor Wheeler

Lab 7: Solid State Laser Modulator

Due Week 12

This is the original work of John Smith

John Smith

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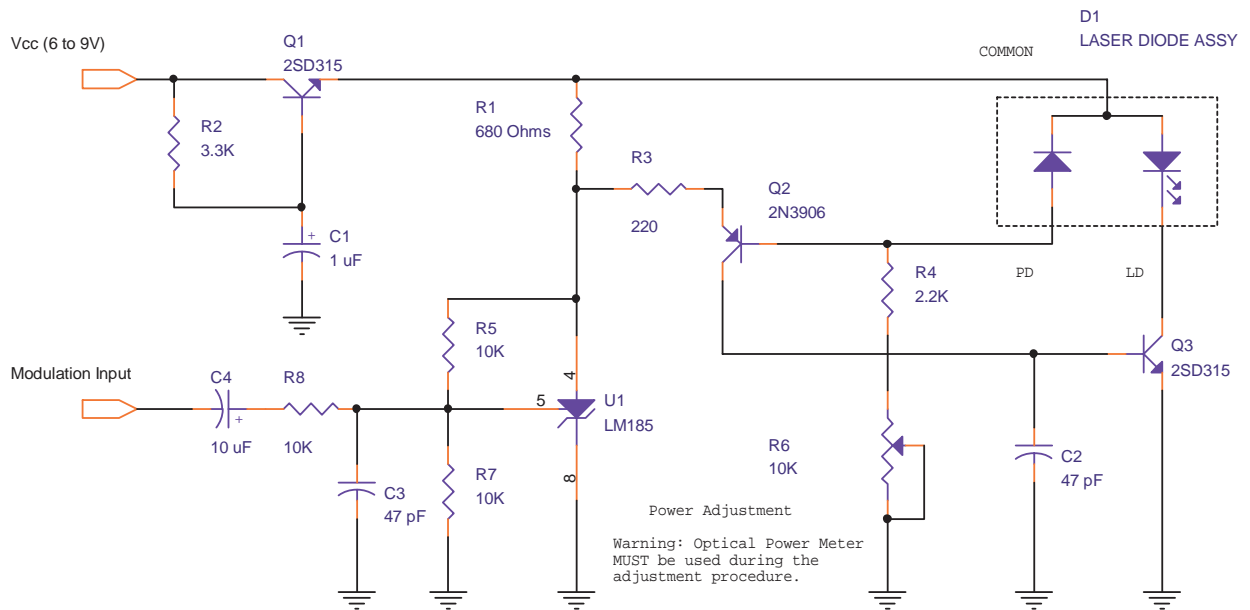Operational Signoff _____

Final Grade _____

Figure 1: Diode Laser Modulator

Notes:

1. All newly constructed circuitry must be included in schematic diagrams. All figures (such as schematics) must have a title.

2. OrCAD is recommended. You can place OrCAD drawings directly into MS-WORD documents to ease report preparation. To do this, highlight the entire schematic page within OrCAD Capture and copy it to the clipboard. Then switch to WORD and paste the data into your document.

3. Each person is responsible for creating his or her own schematic diagram, even if working with a lab partner. Do not share disks.

<u>Recorded Data</u>

V: 1 uS / Div   H: 1 V / Div
07 Feburary 2000   14:56:23
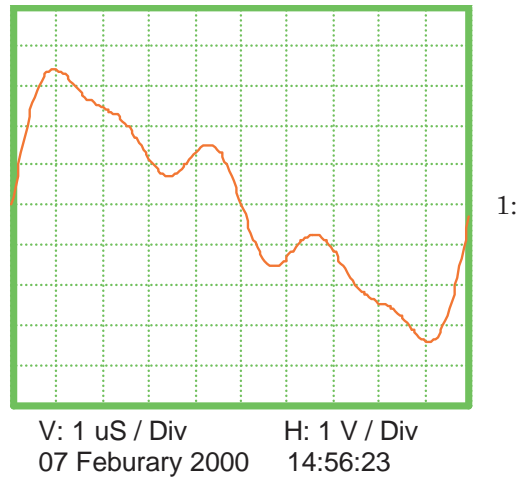
Figure 2: Drive Waveforms
Ch 1: Laser Drive Voltage at Q3 Collector

Notes:

1. All waveforms must be properly labeled. The following are required:

    a) <u>The specific point point in the circuit where the waveform was measured</u>
       ("Laser Drive Voltage at Q3 Collector") in the figure above. <u>This is very important</u>.

    b) The time and voltage readings of the waveform. (If you are using the Agilent 54622D
       or an equivalent instrument) to generate waveforms, this information will
       automatically be generated on the printout.)

2. Waveforms from the Agilent 54622D are inserted into Word documents by using the
    command sequence "Insert > Picture > From File...".

See COMP125 lab #6, "Electronic Data Gathering" (on the instructor's website at `http://faculty.kc.devry.edu/twheeler/comp125/comp125labs.pdf`) for a detailed tutorial on how to do this.

<u>Answers to Questions</u>

1. **Explain the setup you used for optical power measurement.**

   The output from the laser diode was coupled into a ST-style coupler (1 dB loss) and through a 1 meter length of 100 μm multimode fiber from the lab kit (about 0.05 dB loss) into an HP optical power meter S/N 798123.

   The losses in the connector and cable were added to the readings on the power meter. For example, if the meter indicated +20 dBm (100 mW), the actual output at the diode would actually be reported as +21.05 dBm (103.5 mW) after adding the combined losses of the cable and connectors.

2. **Did you have any problems? Detail your troubleshooting procedure.**

   When we initially constructed the circuit, the optical power output could not be adjusted over 10 mW (as recorded using the HP optical power meter). The specification for the laser diode stated that the CW power output is 1 watt. Upon visual inspection, we found that we had accidentally used a 1K pot for R6 (the circuit calls for a 10K part). Upon replacement of R6, we obtained an optical power output of 1130 mW, which more than met specifications.

3. **Calculate the DC efficiency of the laser and its drive circuitry.**

   Step 6 of the laboratory procedure instructs adjusting the circuit for 1W (CW) output prior to measuring the efficiency of the laser. I calculated the efficiency as follows:

   $$\eta = \frac{P_{out}}{P_{in}} = \frac{P_{optical}}{P_{DC}} = \frac{P_{optical}}{(Vcc)(Icc)} = \frac{1W}{(9V)(0.3A)} = 0.37 = \underline{\underline{37\%}}$$

   Where *Vcc* was the power supply voltage, and *Icc* was the measured power supply current.

   Important:

   Please note that the question is restated in each of these responses. This is the recommended procedure, as it best illustrates the relevance of your answer. However, you are not required to do it this way. State your answers in the most clear and direct way possible.

Conclusion

The purpose of this experiment was to observe the operation of a solid-state laser diode in a simple application circuit and measure its DC efficiency. Although we had trouble initially getting the circuit work, we finally obtained an optical output power of 1130 mW, which was 11.3% better than the rated diode output of 1 watt (1000 mW).

In step 6 we measured the efficiency of the circuit as 37%. This is considerably less than the stated efficiency of 50% for the laser diode. Because of this discrepancy, we repeated the measurement and obtained the same result. Also, we noted that another group, Jim Doe and Jane Doe, also obtained values in this range. We were puzzled about the apparent lack of efficiency in the circuit, so we re-read the circuit theory in the lab manual.

At this point, it became apparent that transistor Q_3, which regulates the current to the diode, must also dissipate some of the circuit power. We measured the dissipation of Q_3 by reading I_C and V_{CE} for the device:

$$P_{Q3} = I_C V_{CE} = (0.3A)(2.33V) = \underline{700mW}$$

In step 6 we calculated the total circuit input power as 2.7 W; therefore the actual DC input to the laser diode was (2.7 W - 0.7 W) or 2 watts. The actual DC efficiency of the laser diode is then:

$$\eta = \frac{P_{out}}{P_{in}} = \frac{P_{optical}}{P_{DC}} = \frac{1W}{2W} = 0.50 = \underline{\underline{50\%}}$$

Therefore, we can conclude that the diode sample we were using was within the manufacturer's specifications.

We recommend changing the laboratory manual procedure to reflect the correct procedure for measuring efficiency.