

MEASUREMENT OF OPTICAL FIBER ATTENUATION

PLEASE DO YOUR EXPERIMENT AND REPORT IN GROUPS OF TWO

In this laboratory you will learn the cutback method for measurement of optical fiber attenuation. In the experiment you will also gain some experience with use of the mode scrambler.

- (1) For general background for this experiment, review pages 193-201 of Hecht, Lab 5, and the Lab 5 Supplement.
- (2) Read sections 0.3.2 and 0.4.1 as background for understanding the mode scrambler and optical fiber attenuation. The Newport manual uses “ \tilde{A} ” for the attenuation of a fiber in dB/km. Here we will use “ α ”.
- (3) Now, for specific background for conducting the experiment, read Project #2 in the Newport manual through section 2.3. Don't start the experiment yet. Refer back to sections 0.3.2, 0.4.1, 2.1, 2.2, and 2.3 to deal with questions that might arise as you conduct the experiment.
- (1) Consult the manufacturer's catalog to determine the basic specifications for the F-MLD fiber you are using. What is its attenuation at 850 nm? At 1300 nm? How does this compare with what is indicated on the spool itself? What would you expect α to be at 630 nm? At 1550 nm?
- (5) Follow the same precautions you have used in the past in using the laser and the methylene chloride.
- (6) You will start with a spool of fiber with a length of fiber greater than 70 meters or so. Carefully note the actual length of the fiber on the spool you are using as indicated on the label. Be sure to include all "updates."
- (7) Make a record of the length of your spool at the beginning of your experiment.
- (8) Carefully follow the procedure to prepare both ends of your spool as given in the Newport manual in section 2.5 (part 1).
- (9) Set up the experiment by following section 2.5 (parts 2 and 3). Be sure that your detector has its OD 3 neutral density filter attached. Measure the optical power available from your laser and make a record of it. Position the microscope slide cover glass holder between the laser and the fiber coupler. Ask your instructor about use of the microscope slide cover glass.

Don't look directly at the laser or at any of its reflections from the microscope slide cover glass. Instead, view them as projected on a note card or sheet of paper. You will observe *indirectly* the spot of light reflected from the fiber input face and adjust the fiber coupler (in particular, the z-adjustment) so that the spot is in focus. You can use a small card to block the fiber input face to identify the appropriate reflection. When the spot is in focus, this indicates that the fiber input face is in the focal plane of the 20X objective lens. This should facilitate obtaining maximum coupling of light into the fiber.

- (10) Position the mode scrambler as specified in section 2.5 (part 4) and very carefully follow 2.5 (part 5). Be careful—you could break the fiber. In the middle of section 2.5 (part 5) you are asked to examine the far-field distribution of the output of the fiber. Refer back to 1.6.2 (part 6) for more information.

Observe the glow of your spool of fiber as you adjust the mode scrambler. Ask your instructor if it would be possible to dim the lights in the laboratory while doing this. Watch especially the section of the fiber just leaving the scrambler. As you adjust (lightly tighten) the scrambler there will be a point where this portion of fiber will glow as higher order modes are passed by the scrambler into the cladding. At the same time, see if you notice a change in the glow of the spool.

Look at the output from the fiber on a sheet placed about 5 cm from the fiber end. This way you will clearly see the scrambler impact on the distribution of modes within the NA. Note that with improper adjustment there could be some light outside the expected NA.

- (11) Measure the power output of the 500-m spool as specified in 2.5 (part 6). Note the detector-end fiber position and its relationship to the detector. You will need to reproduce this relationship in step (14) below.
- (12) When you have finished all of the above, carefully follow section 2.5 (part 7). Be sure you do not disturb the laser-end of your fiber and the mode coupler setting. Your instructor or laboratory assistant will assist you in cleaving the “new” fiber end at your optical table.
- (13) Mark on the fiber spool the amount of fiber you removed and today’s date. What is the new length of the fiber on the spool?
- (14) Position the “new” fiber end at the detector as close as possible to that observed in step (11). Measure the new output power.
- (15) Finally, complete section 2.5 (part 8). Derive the equation below and use it for your calculation of α , the attenuation of the fiber in dB/km.

$$\alpha = 10 \{ \log_{10} (P_{\text{out}2}/P_{\text{out}1}) \} / (L_1 - L_2)$$

where L_1 = the actual length of the fiber (in km) on the spool,
 L_2 = the actual length (in km) of your short fiber,
 $P_{\text{out}2}$ = power output from the short fiber, and
 $P_{\text{out}1}$ = power output from the spool.

(16) Each group can borrow a laboratory manual to refer to as needed to finish your laboratory report. This must be returned in time for the laboratory next week.

6. Show here your derivation of the formula for α .

7. Determine α from your data. Compare your attenuation result to that indicated by the manufacturer. Explain any difference(s).

8. What fraction of the available laser power was supplied to the fiber?

9. Discuss any problems you had in doing the experiment.

