Report 02

Optical Fiber Data Transmission System

Team 1C

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Total score ______ **/ 5.0p.**

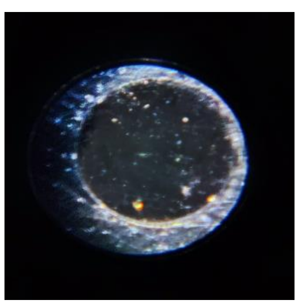
1. Goal of the exercise .

- Inspect the tip of a polished optical fiber under high magnification.
- Learn the proper technique to clean the tips of optical fibers in connectors.
- Understand the effects of 'attenuation' in optical fiber.
- Demonstrate optical fiber's ability to carry different wavelengths of light.
- Hear the effects of electromagnetic interference (EMI) caused by a DC motor on copper cabling technology.

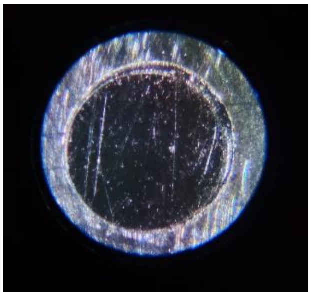
2. Lab run

2.1 Inventory

- Identify the components from Table 1.
- Locate the Inspection Microscope and connect it with the fiber optic with a ST type connector, Adjust the Zoom setting until focus.
- Repeat for the remaining Optical Fibers.
- Turn Off the Microscope.



2.1 i (Focused Optical Fiber 5m)

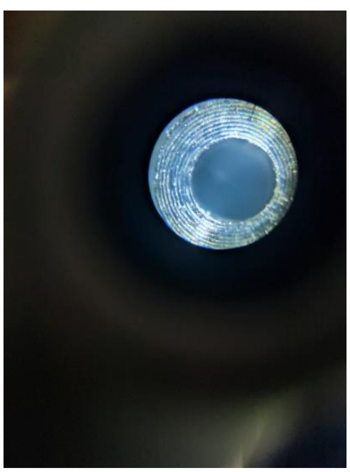


2.1 ii (Focused Optical Fiber 3m)

2.2 Fiber Tip Cleaning

- Take 1 non-dusting tissue and isopropyl alcohol.
- Fold the Tissue twice to get 4 layers and apply alcohol to it.
- Clean the side of the ferrule.
- With the end of the fingernail, Clean the forehead of the ferrule with a clean part until it makes a squeaking sound.

2.2 i (Clean End of Optical Fiber 3m)



2.2 ii (Clean end of Optical Fiber 5m)

2.3 Basic Light Transmission through an Optical Fiber

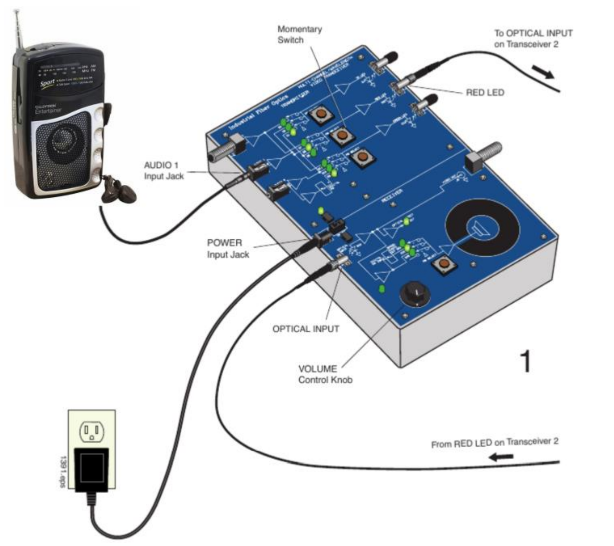
- Select an optical fiber and look through one end.
- Move the other end across different light sources around the room.
- See the different brightness and color change.

2.4 ST Fiber Connections

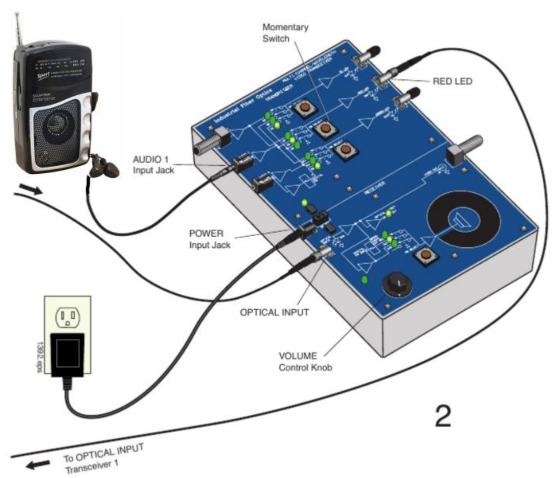
- St type connection are joined via bayonet and locked ring
- Remember to use correct form for connection.

2.5 Voice Transmission

- Assemble the System as shown in Fig 2.4 i.
- Located directly to the right of the power jack is the on/off switch for the Transceiver. Push the switch tab to the left to turn the Transceiver on. At this time the green LED above the power jack and switch should light up. If not, make sure both ends of the Power Adapter are firmly plugged in.
- Set the VOLUME control knob to the 9 o'clock position.
- Press the middle momentary switch in the center of the TRANSMITTER portion of the Transceiver until the green LED labeled D6 is lit.
- Press the momentary switch in the RECEIVER portion of the Transceiver until the LED labeled D19 is lit.
- Test the proper operation of the system.
- Locate the GREEN LED receptacle in the central right portion of the Transceiver's front panel. Detach the 10-meter fiber connected to the RED LED receptacle and attach it to the GREEN LED receptacle.
- Press the bottom momentary switch until the LED labeled D11 is lit.
- Test the proper operation of the system. Can you observe any difference?
- Take the time now to study how the momentary switches work. Analyze the schematic shown by the white lines on the front panel of the Transceiver. Use it to understand how a signal from any one of the three input jacks routes to one of the three fiber optic LEDs using the three momentary switches.



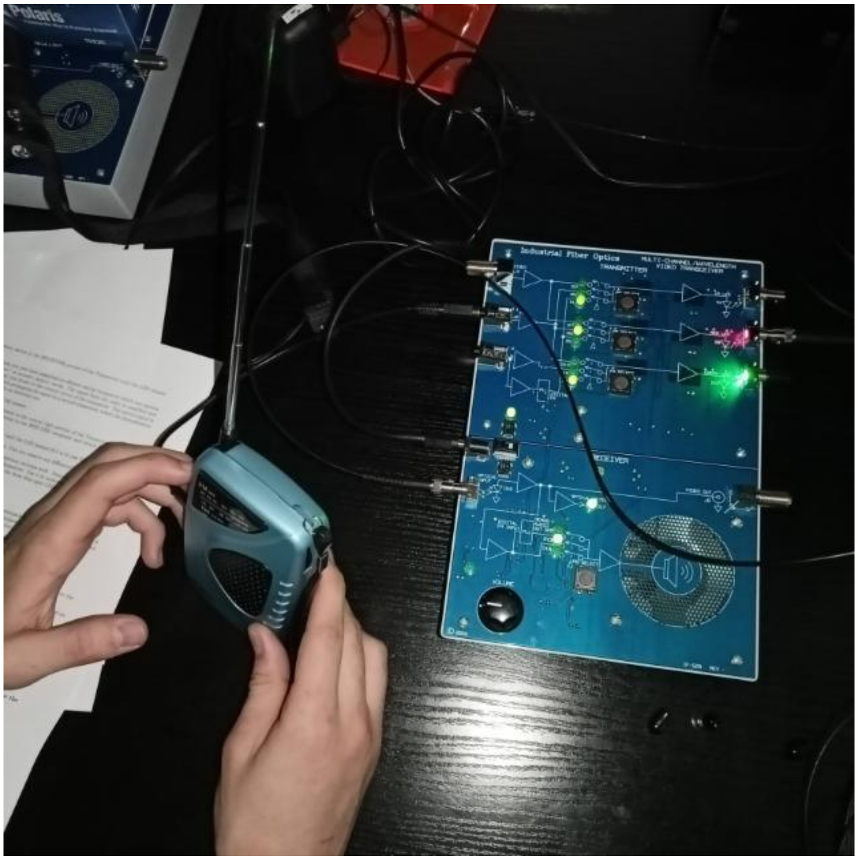
2.5 i (Setup for Tranceiver 1)



2.5 ii (Setup for Transceiver 2)

Results:

- We saw that with Red Light we had the best outcome and With Green light the worst outcome.
- D6 terminal for Red light for best transmission.
- D11 terminal for Green Light for Worst transmission.

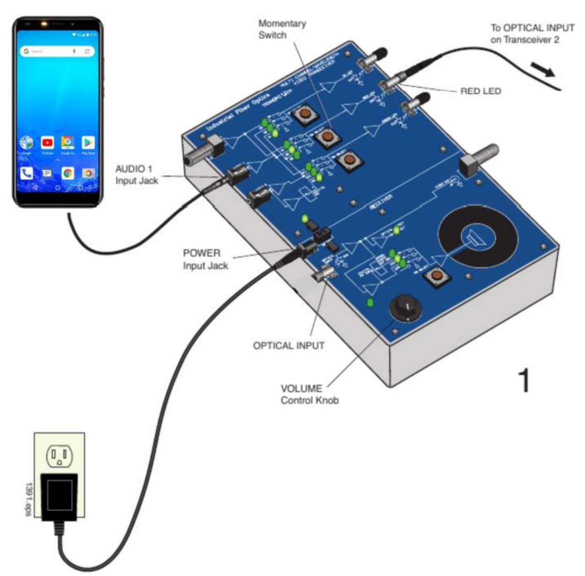


2.5 iii (Our Actual setup for the Experiment using 1 trasceiver)

2.6 Analog vs Digital Transmission

- Assemble the system as shown in Figure 2.6 i. With a minijack cable use your smartphone as sound source. Unlike the figure, the second end of the minijack attach to AUDIO 2 input. Second transceiver (not shown in the picture) set as signal receiver.
- On the emitter turn on D10 switch to allow analog transmission.
- On the receiver turn on D19 switch to allow analog transmission.
- Turn on music on your smartphone and check sound quality.
- Detach optical fiber end from receiver and check how to sound quality changes when you move the fiber end (put it closer or further, change angular position).
- Attach the optical fiber back to the receiver. Change the switch on the transmitter to D9 and on the receiver to D20. This will change the transmission mode to digital.

- Compare the sound quality with analog transmission. Repeat the analysis with optical fiber detached from the receiver.



2.6 i (System setup to demonstrate impact of EMI)

Results:

- We use Analog because it's better to check results.
- When switched to digital, It shows a not so good quality for high bass and drum sounds.
- We can barely hear the sound when Optical Fiber is 3 cm away from the receiver input.
- Sound was better amplified when red light was used.
- Soft sounds like Piano plays much better on digital system than analog system.
- Digital system is very good for quality but very sensitive.

2.7 Demonstration of EMI

- ### Experiment A
  - Assemble the system as shown in the Figure 2.6 i. Use your smartphone as the source of sound - connect the minijack cable to it. Connect the minijack to AUDIO 1. Second transceiver (not shown in the picture) set as a signal receiver.
  - Place the electric motor near the transceiver 1. Do not connect the power supply to the motor yet.
  - Turn on the transceiver
  - Press the middle momentary switch until the LED labeled D6 is lit.

- Set the VOLUME control knob in the receiver section of the Transceiver to the 9 o'clock position.
- Press the momentary switch in the RECEIVER portion of the Transceiver until the LED labeled D19 is lit.
- Test the proper operation of the system by turning on the music in your phone. The sound level at your phone should be low - otherwise very strong signal disturbance occurs.
- Connect the power supply to the motor. Carefully insert the reel of the minijack cable around the motor so that the motor is inside the reel.
- Note the difference in sound quality when the motor is on and off.
- Turn off the motor.
- Move the motor so it stands between two transceivers.
- Carefully insert a reel of fiber optic cable connecting both transceivers around the motor, just like it was done with the minijack cable.
- Note the difference in sound quality when the motor is on and off.
- Analyze the system and draw conclusions about the impact of electromagnetic interference on fiber optic transmission.

Results:

- For Optical Fiber, Electromagnetic interference does not change the quality. We have very little noise/disturbance.
- For Aux cable, Electromagnetic interference changes the quality. We have more noise/disturbance.

2.8 Measuring Fiber Attenuation

- Turn on the optical fiber test set.
- rotate the Display Selector Switch to 200 µW and set the wavelength selector switch to 850 nm.
- Using the 1-meter optical fiber, assemble the system as shown in.
- Note the test set display's reading.
- Change 1-meter fiber to 3-meter fiber. If at any time during this experiment the test set display reads less than 20 µW, switch the meter to the 20 µW.

- Note the test set display's reading and change the fiber to 10-meter fiber. Again, note the result.
- Move the wavelength selection switch on Fiber Optic Test Set to the 650 nm.
- On the transceiver, reconnect the optical fibre to the RED LED output. Repeat the experiment for 3 fibers (do not change the wavelength selection switch).
- On the transceiver, reconnect the optical fibre to the GREEN LED output. Repeat the experiment for 3 fibers (do not change the wavelength selection switch).
- Perform an analysis of the results obtained. Calculate the attenuation of the optical fibre. Note: The 3 LEDs used in this exercise have different power. Compare the fiber optic attenuation independently for 3 wavelengths.

Results:

Red Light- 650 nm
Green Light- 530nm
Infrared Light- 850nm

Lengths	Light	Power	Display Reading
5 m	Red	200 uW	64.9 uW
5 m	Green	200 uW	183.5uW
5 m	Infrared	200 uW	5.3 uW
1 m	Red	200 uW	110.5 uW
1 m	Green	2 mW	0.25 mW
1 m	Infrared	200 uW	188.5 uW
3 m	Red	200 uW	102.8 uW
3 m	Green	2 mW	0.248 mW

3 m	Infrared	2 mW	0.09 mW

2.8 i (Results for Experiment)

3. Applications of the phenomena .

- Optical Fiber –
  1) Telecommunications
  2) Medical Equipment
  3) Sensor to detect environmental factors
- ST connectors –
  1) Telecommunications for high-speed data transmission. [1]
  2) Military and aerospace applications for their durability. [1]
  3) Industrial settings for their resistance to electromagnetic interference. [1]

5. Questions

1. The exercise used fiber optics with ST connectors. What other connectors are used in fiber optics, how do they differ? (1 pt)
   - ➢ Types of Connectors
     - ST Connector: ST (Straight Tip) connectors are circular in shape and use a push-and-twist mechanism to connect to the fiber. They have a key on the connector body to ensure proper alignment. [1]
     - SC Connector: SC (Subscriber Connector) connectors are also circular in shape but have a square snap-in mechanism. They are easier to install than ST connectors and are commonly used in data communications. [1]
     - FC Connector: FC (Ferrule Connector) connectors use a screw-on mechanism to connect to the fiber. They have a threaded coupling and a metal housing that provides more durability and protection than other connectors. [1]
     - LC Connector: LC (Lucent Connector) connectors are small, compact connectors that use a snap-in mechanism. They are similar in size to SC connectors but offer higher density and are often used in high-density patch panels. [1]

2. Draw a block diagram of the sound transmission system used in the exercise, taking into account the successive stages of signal processing (the input device - the signal source is the radio, the output - the speaker). (1 pt)

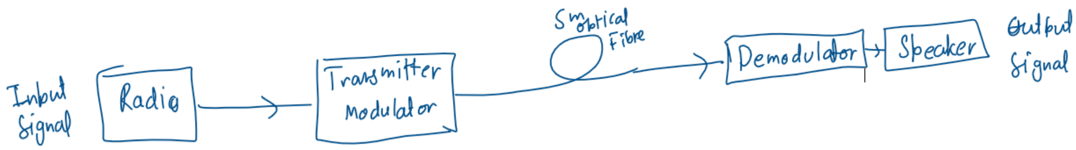
➤ 

Figure 1 (Sound Transmission System)

3. What is the reason for the superiority of digital over analog transmission demonstrated in the sound transmission experiment? (1 pt)
   - ➤ Firstly, we noticed that the sound from the speaker was much clearer and had no background noise when we used digital transmission compared to analog transmission. This made it easier to understand the signal without any constant hissing in the background.

   - ➤ Another good thing about digital transmission is that it's not ambiguous. The signal is either fully decoded or completely lost depending on the threshold signal for the receiver. We saw this when we unplugged the optical fibre from the receiver and moved it away from the decoder. With analog transmission, the volume of sound decreased and other signals interfered, but with digital transmission, the sound was loud and clear until it suddenly stopped when it reached a specific distance that the decoder couldn't handle.

   - ➤ Lastly, digital transmission can handle much higher levels of noise because it only uses two units of information "1" or "0".

4. Formulate a conclusion from the attenuation measurements made. (2 pts)
   - ➤ We observed that as the length of the optical fibre increased, the signal strength decreased. We also noticed that shorter wavelengths had a lower proportional loss of signal strength over distance. For instance, at a wavelength of 650nm, the difference in signal loss between 1m and 3m of optical fibre was much lower compared to that at 850nm. Hence, to minimize loss of the output signal, we should use light signals with higher wavelengths for shorter distances and lower wavelengths for longer distances when transmitting data.

Lengths	Light	Power	Display Reading	Attenuation
0.005	Red	200	64.9	-36.24489394
0.005	Green	200	183.5	-45.27272137
0.005	Infrared	200	5.3	-14.48551739
0.001	Red	200	110.5	-54.84664565

0.001	Green	2000	250	-41.93820026
0.001	Infrared	200	188.5	-59.48562718
0.003	Red	200	102.8	-44.67683729
0.003	Green	2000	248	-32.32600861
0.003	Infrared	2000	90	-23.52182518

6. **References**

[1] https://chat.openai.com