



*Lab Experiment # .....*

Name: \_\_\_\_\_ Roll No: \_\_\_\_\_ Date: \_\_\_\_\_

## **SETTING UP A FIBRE OPTIC DIGITAL LINK**

### **PERFORMANCE OBJECTIVES**

The objective of this experiment:

1. Is to set up an 850nm and 650nm fiber optic digital links.
2. To measure the maximum bit rates supportable on these links.

### **HARDWARE REQUIREMENTS**

- Module Kit: OFT Trainer
- Fiber cables: 1m and 3m
- Power Supply module, Input: 220-240 V AC, 50Hz. Output: +5V DC.
- Power interface cable with DIN jacks at both ends.
- Two channel, 20MHz Oscilloscope.
- Function generator, 1Hz-10 MHz
- BNC-BNC cables.
- Regular patch cord.
- 3-plug patch cord.

### **DISCUSSION**

The OFT can be used to set up two fiber optic digital links, one at a wavelength of 650nm and the other at 850nm. LED1, in the Optical Tx1 block, is an 850nm LED, and LED2, in the Optical Tx2 block, is a 650nm LED.

PD1, in the Optical Rx1 block, is a PIN detector which gives a current proportional to the optical power falling on the detector. The received signal is amplified and converted to a TTL signal using a comparator. The GAIN control plays a crucial role in this conversion.

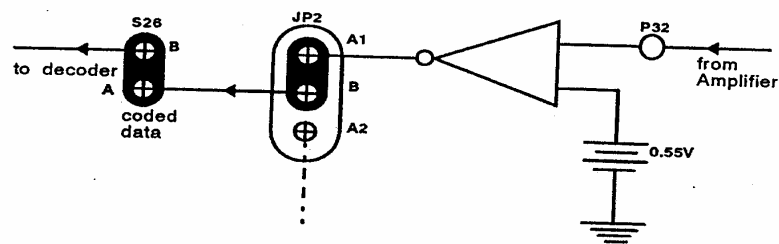
PD2, in the Optical Rx2 block, is another receiver which directly gives out a TTL signal. Both the PIN detectors can receive 650 nm as well as 850nm signals, though their sensitivity is lower at 650nm.

### **PROCEDURE**

1. The OFT Trainer comes with a power supply module, operating at 220-240AC, 50Hz. The output of the power supply module is +5V DC (regulated) and is available through a DIN socket. A power-interface cable with DIN jacks at both ends is provided for connecting the power supply module to the OFT.
2. Connect one end of the power-interface cable to the power supply module, and the other end to the OFT.

## SETTING UP A DIGITAL LINK AT 850nm

3. Set the switch SW8 to the DIGITAL position. Switch the power on.
4. Connect a 1m optical fiber between LED1 and the PIN diode PD1.
5. Remove the shorting plugs of the coded data shorting links, S6 in the Manchester coder block and S26 in the Decoder & clock recovery block. Ensure that the shorting plug of jumper JP2 is across the posts B & A1 [for PD1 receiver selection].
6. Feed a TTL signal of about 20 KHz from the function generator to post B of S6. Use the BNC I/Os for feeding and observing signals. Observe the received analog signal at the amplifier post P31 on channel 1 of the oscilloscope [trigger the oscilloscope with channel 1 signal]. Note that the signal at post P31 gets cut off above 3.5V. Increase and decrease the GAIN and observe the effect.
7. Observe the received signal at post A of S26 on channel 2 of the oscilloscope while still observing the signal at P31 on channel 1 [trigger the oscilloscope with channel 1 signal]. Note that the signal at S26 is the inverted version of the signal at P31. Vary the GAIN potentiometer setting. Note that even though the received signal at P31 changes with the gain, the output at S26 does not. Reduce the gain till the signal at P31 is less than 0.5V. [If the signal does not drop below 0.5V even at the lowest gain setting, pull the fiber out slightly at the receiver to reduce the level below 0.5V]. Note that the signal S26 is now becomes all high. This is because the P31 signal is fed to the comparator-cum-inverter to give the signal of S26 as shown in figure. The comparator reference voltage is 0.55V, and unless the signal amplitude is greater than 0.55V, the comparator output is high. Verify this.



8. Set the gain such that the signal at P31 is about 2V. Observe the input signal from the function generator on channel 1 and the received TTL signal at post A of S26 on channel 2. Vary the frequency of the input signal and observe the output response. What is the maximum bit rate that can be transmitted on this digital link?
9. Repeat Steps 6, 7 & 8 with the 3m fiber.

## SETTING UP A DIGITAL LINK AT 650nm

10. Use the 1m fiber and insert it into LED2. Observe the light output at other end of the fiber [keeping it away from the eye]. The output is bright red signal. This is because the light output at around 650nm is in the visible range. The other end of the fiber should now be inserted into PD1.

11. Repeat Steps 6, 7 & 8 with this new link.
12. Use the 3m fiber and setup the 650nm digital link between LED2 and PD1. Repeat Steps 6, 7 & 8.

### **SETTING UP A TTL TO TTL DIGITAL LINK AT 650nm**

13. Change the shorting plug in jumper JP2 across the posts B & A2 [for selection of PD2 receiver]. Use the 1m fiber to connect LED2 and Optical receiver PD2.
14. Feed a TTL signal of 20 KHz at post B of S6 and observe the received TTL signal at post A of S26. Display both the signals on the oscilloscope on channels 1 & 2 respectively [triggering with channel 1]. Note that the GAIN control does not play any role now in operation of the link; the receiver at PD2 is an integrated PIN diode and comparator that directly gives out a TTL signal. Vary the frequency and find the maximum bit rate that can be transmitted on this link.
15. Repeat Steps 13 & 14 using the 3m fiber.

### **SETTING UP A 850nm TTL TO DIRECT DIGITAL LINK**

16. Use the 1m fiber to connect LED1 and PD2. Feed a TTL signal of 20 KHz at post B of S6 and observe the received signal at post A of S26. Display both the signals on the oscilloscope. An 850nm TTL to direct digital link is obtained. Vary the frequency and find the maximum bit rate that can be transmitted on this link.
17. Repeat Step 16 with 3m fiber.

### **COMPARING RESPONSITIVITY OF PIN DIODE AT 850nm AND 650nm**

18. Change the shorting plug in JP2 to connect A1 and B (for PD1 receiver selection). Using the 1m fiber connect LED1 (850nm) and PD1. Let the GAIN control to be at the minimum level. Feed a 20 KHz TTL signal at post B of S6. Measure the peak to peak voltage at P31 and designate it as V1.
19. Now connect the fiber between LED2 (650nm) and PD1 without changing any other setting. Measure the peak to peak voltage at P31 and designate it as V2.
20. The factory setting for the light output at the end of 1m fiber for LED1 is 3dB higher (two times) than that for LED2. The PIN diode current “ i ” can be written as:

$$i = \rho P$$

Where P is the optical intensity of light falling on the detector and  $\rho$  is the responsivity. The voltage at P31 is directly proportional to the PIN diode current “i”. Using the results of Step 19 & 20, compare the responsivity of the diode at 650nm and 850nm using the expression

$$\frac{V1}{V2} = \frac{\rho1P1}{\rho2P2}$$

Where  $P_1$  is twice  $P_2$  (at factory setting) and  $\rho_1$  and  $\rho_2$  are responsivities of the diode at 850nm and 650nm respectively.

### **OBSERVATIONS**

1. What is the maximum bit rate that can be transmitted on the 850nm digital link?
2. What is the maximum bit rate that can be transmitted on TTL to TTL digital link at 650nm?
3. What is the maximum bit rate that can be transmitted on TTL to Direct digital link at 850nm?
4. Find  $V_1$  and  $V_2$  and compare the responsivity of the diode at 650nm and 850nm.
5. Derive the expression given in Step 20.

### **REVIEW QUESTIONS**

1. Define Responsivity?

---

---

---

2. Define Sensitivity?

---

---

---

3. Define the working principal of PD2 receiver which directly gives out a TTL signal?

---

---

---