Plastic Fiber Optics (CA-1400)

Optical data transmission is nowadays a standard technique in telecommunication. Glass fiber lines are widespread all over the globe. However, in multimedia sys-tems, automotive systems, home networks or control systems plastic optical fiber (POF) networks can often be found. Rea-sons for the choice of POF can be the low-er price, the need of only short transmission lines (50 – 100 m), environmental conditions not suited for glass fiber, or simply the easy way of installation of a POF network.

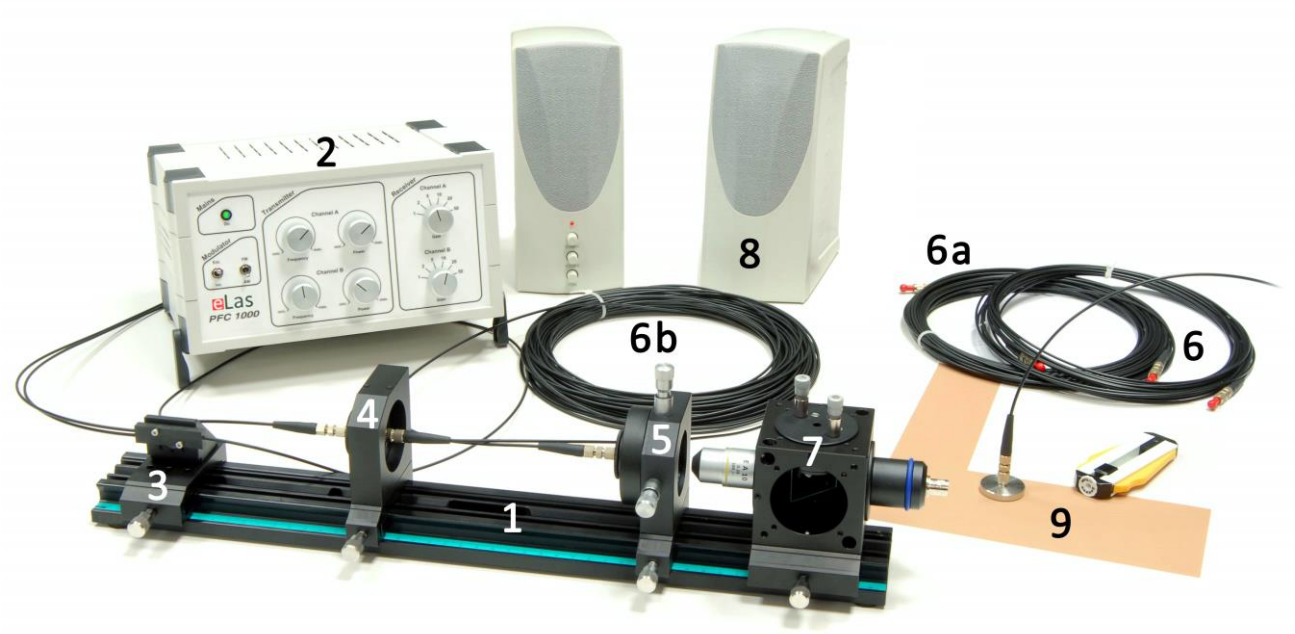
Within this educational kit the basics of plastic fibers concerning fiber preparation as well as data transmission are treated. The preparation of a POF will be trained to the students. Stripping of a fiber, and as-sembling and polishing of a connector are practiced. The measurement of transmis-sion losses of different lengths of POFs as well as the setup of a complete two chan-nel low frequency data transmission sys-tem will be performed. All necessary com-ponents, fibers and control electronics like modulator, transmitter, receiver, demodula-tor and an audio amplifier with two speak-ers are included.

Other signal sources like a CD player or a microphone can be connected to the transmitter. For the measurements a two channel oscilloscope is necessary and can be ordered as an option.

Educational Objectives of Investigation

- LED Transmitter
- LED Signal Modulation
- Si Photo Detector Receiver
- Dichroic Beam Splitter
- Dual Wavelength Data Transmission
- Plastic Fiber Handling and Preparation
- Plastic Fiber Attenuation
- Signal Beating and Cross Talk

Setup and Components



1	Flat Rail 500 mm with scale
2	Controller for LED transmitter with frequency generator, photo diode receiver and demodulator
3	POF Y-coupler on carrier
4	FSMA coupler in holder on carrier
5	FSMA coupler in XY adjustment holder on carrier
6	3 POF cables with two FSMA connectors (length 10 m, 20 m, 30 m)
7	Light receiver system with beam separation and detectors
8	Pair of active stereo speakers
9	Set of tools for fiber preparation and assembling of FSMA connectors
10	Set of necessary BNC cables and adapters (not shown)
11	User manual (not shown)

Ordering Information

For ordering the Plastic Fiber Optics experimental kit (CA-1400)
use ordering number: 490091400

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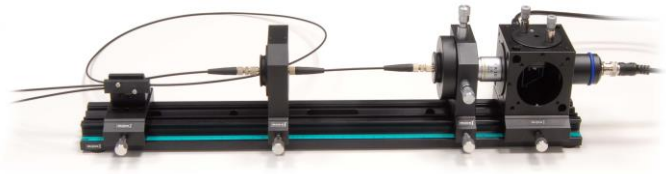
Measurements and Handling

Some of the possible measurements are presented in the following list:

- **Preparation of plastic fiber (POF) and assembling of POF connectors**

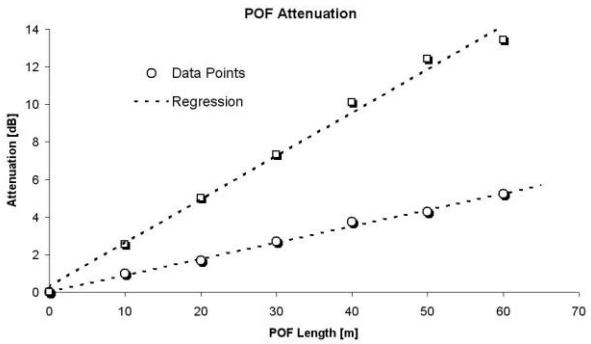
Although the setup comes already with terminated and polished fibers, a set of tools, a bare fiber coil and connectors are added to get experienced to prepare the fiber to be connected and subsequently to be polished. Since the FSMA connectors can be removed easily from the fiber it can be a first task of the students to assemble a pair of connectors to a piece of fiber, as well as grinding and polishing the fiber tip for optimum transmission.

- **Attenuation of connector pair**



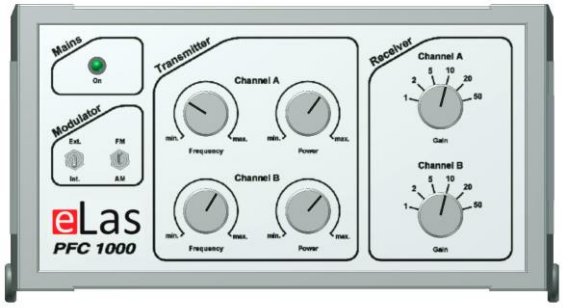
A two channel (red and green LED) transmission line with a short piece of POF is set up. The signal values of the two channels are detected and the attenuation of the two connectors is calculated. The attenuation of the short fiber piece may be neglected in first approximation.

- **Attenuation of plastic fiber lines**



The attenuation of three measurement fiber lines (10 m, 20 m or 30 m) and their combinations is measured for both, the red and the green channel. The values are plotted as a function of the fiber line and the attenuation per meter and per km is calculated. The difference in the attenuation for the red and the green channel is figured out.
The measurements are repeated for FM modulated signals. Is there a difference compared to the measurements with AM modulation? May there be some signals lost by the data transmission?

- **Attenuation of plastic fiber lines**



The transmitter and modulator unit of the Plastic Fiber Controller PFC 1000 converts electrical to optical signals which are launched into two plastic optical fiber channels by a red and a green LED. These signals can either be generated by a CD player, a microphone or other audio sources. Additionally, the transmitter contains an internal frequency generator for each of the two independent channels. A two position switch allows setting the modulation to amplitude (AM) or frequency modulation (FM) at a fixed carrier frequency.

The receiver unit of the PFC 1000 receives and demodulates the signals transmitted by the POF setup. Each of the two channels are separately amplified and can be displayed on an oscilloscope via BNC outlets.

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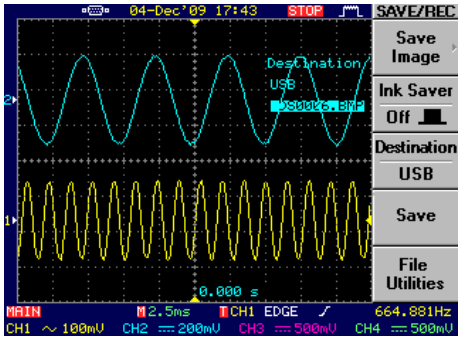
Transfer of sinusoidal signals

Some examples of signal outputs of the PLC 1000 displayed on a digital oscilloscope are given below.

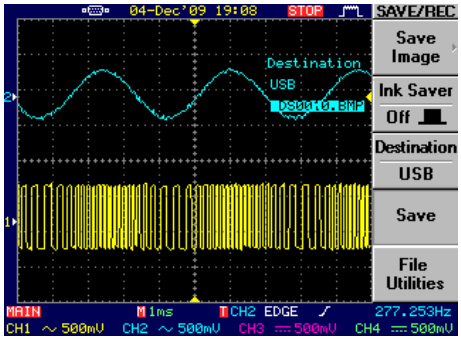
- **Modulator output at AM modulation**



Feeding the two modulated output signals to the oscilloscope the graph may look like the following picture. Here one signal frequency is chosen as about three times the frequency of the other signal.

In an ideal case the demodulator output signals of the Receiver may look similar, but reduced in their amplitude.

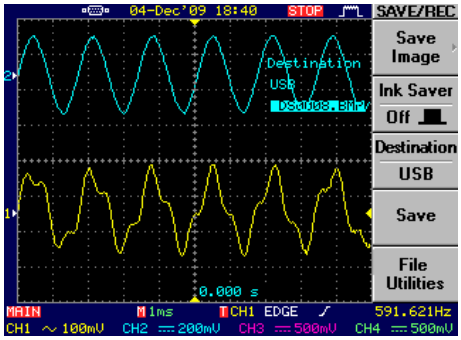
- **Modulator output and signal at FM modulation**



A sinusoidal signal (upper curve) is transmitted in the FM modulation mode like shown in the lower curve. A rectangular TTL signal is modulated in its frequency according to the sinusoidal input signal.

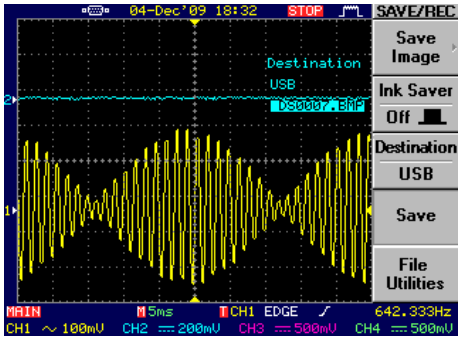
After transmission via the POF setup the demodulator output signal should look like the upper curve again. However, there is a signal intensity threshold at which the demodulator is not working properly any more.

- **Signal cross talk due to spectral overlap**



If one signal channel has a much higher amplitude than the other, the effect of cross talk may appear, i.e. the signal of one channel is more or less present at the other channel as well. This behavior is presented in the next graph which shows the “pure” signal from the modulator output in the upper curve and the same signal overlayed by the second channel’s signal from the demodulator output in the lower curve.

- **Signal beating**



If the two input signals have almost the same frequency, one can observe a signal beating which is the result of alternating constructive and destructive interference of the two signals. This beating is nicely observed if the two signals are detected by one photo detector and the amplitudes of the two signals have the same heights.

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