Optical Wireless Transmission in Laboratory

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***Abstract*— This document describes a modification of point-to-point FSO (free space optics) called Ronja for laboratory requirements. The device operates in the visible red spectrum with a communication speed of 10 Mbps full-duplex over a distance of 900 metres. Ronja was adjusted for the needs of laboratory assignments, where additional voltmeters measure RSSI (received signal strength indication) at both ends of the link. The measuring device provides adjustment of power of the transmitting LED via computer, measures and sends RSSI values to a PC via USB or RS232, turns off the Ronja device together with the computer. Own design of the mechanical construction for targeting the pipes of Ronja was developed.**

***Keywords*—FSO, Optical wireless transmission, Ronja.**

I. Introduction

THIS paper describes amodification of the cheap free technology point-to-point FSO device from project Ronja (Reasonable Optical Near Joint Access) [1], which is used in optical networks laboratory in the Department of Telecommunications, Brno University of Technology.

Ronja is an optoelectronic device, which uses a narrow light beam as a transmission channel in the atmosphere. This beam is created through a lens system. The purpose of the device is wireless connection of two separate computer networks at a transfer speed of 10 Mbps. The maximum communication distance is 900 metres and must be in line of sight. FSO Ronja is made up of three main parts: transmitter, receiver and interface. The transmitter contains a LED (light emitting diode) for transmitting data and the receiver contains a PIN photodiode with very short switching time as the detector. Ronja communicates in full-duplex (allows communicating in both directions simultanelously). The interface alters the signal levels and impedances for optical transmission. It generates signals at 1 MHz, which is necessary for a foolproof function of the Ronja device when there is interference such as sunlight or another shining source, which could interrupt the connection.

II. Modification of the Ronja Device in Laboratory

Several devices were added to the Ronja for purpose of acquainting students with the functionality and capabilities of this FSO. Also was created own unique mechanical construction.

A. Measuring device

This device is designed for laboratory needs. Its task is to measure the RSSI voltage at both receivers and send their values to PC via USB or RS232 port. The transmitting diode current is controlled from a PC via this measuring device. The measuring device can turn off the entire Ronja device from the PC keyboard. There is a special plug with a relay inside and it is connected to USB power supply, so if the PC is shutting down, this plug will disconnect the power supply to the entire device and the Ronja. The measuring device controls>is controlled by Atmega8 microcontroller from Atmel. The wiring diagram of the measuring device is shown in Appendix A.

B. Modification of the transmitter

The Ronja device is designed to work over distances from 135 to 900 meters, but consoles in laboratories are only a few meters from each other. So it is necessary to reduce the intensity of transmitter light beam to simulate a longer link. That is why an NPN transistor is added serially to the transmitting LED in the transmitter. The transistor is connected between the transmitting LED cathode and the ground. The transistor reduces the current in the transmitting LED via increasing the resistance in the transistor base, so the light beam from LED is weaker. This regulation of current can be done electronically from the PC via resistors R17, R18, R23 – R27 in the measuring device or via a potentiometer at the cover of the transmitter pipe.

C. Voltmeter at the receiver

At the cover of the receiver pipe a voltmeter is fitted to measure and display the current value of RSSI. Single-line LCD display with backlight is used. The voltmeter is controlled by the Attiny26microcontroller from Atmel. Using this voltmeter the targeting of both ends of the Ronja device is much more comfortable.

III. Measuring program in computer

The Hyperterminal program is used to communicate with the measuring device. This program is part of each operating system from Microsoft. The job of Hyperterminal is to monitor and record RSSI values for both receivers, which come from the measuring device. Every second, the Hyperterminal software shows the RSSI values measured for both receivers. The data should be logged, so that it is

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possible to create a graph of RSSI values in Excel for a longer period of time. The current of the Regulation of current one transmitting diode is controlled via keys 1 to 7, where the leftmost number has the most significant effect on the limitation current and the rightmost number has the least significant effect. Every number can have the value 1 or 0, where 1 increase light beam. Using this program you can turn on and off the power supply to the Ronja device. If button “z” is pressed, Ronja is supplied with power, button “v” cuts off the power supply. The purpose is to save energy when there is no measurement running on the Ronja device. An example of the Hyperterminal window is shown in Fig. 1.

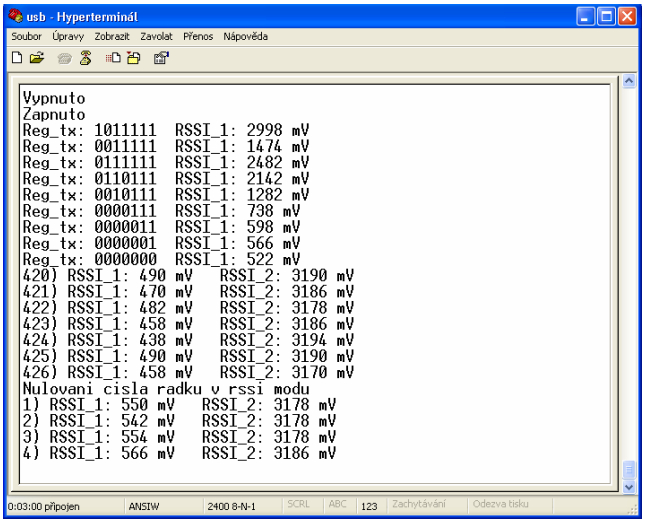


Fig. 1. Example of data in Hyperterminal window.

IV. Mechanical Construction

There is a 100 mm lens in the front part of each pipe. Laserucut metal plates are supposed to fit the transmitter and receiver to the center of the pipe, where these devices move inside pipes to set the focal distance of the lens. The receiver setups in pipe only once, so construction of metal plates are simple. But metal plates for the transmitter are much more complicated, because transmitter can move in pipe via spinning the handle on the screw rod. This is cause change of diameter the light beam from the transmitter. Under each pipe there is very fine targeting system, which is assemble from two screw rods. Vertical screw rod has purpose to support pipe and vertical advance of the pipe, while horizontal screw rod is for horizontal advance of the pipe. For tight fix of the pipe on its position there are always two nuts to counter with each other. Two pipes with targeting system are assembled to console, which is screwed to wall. Every iron part from this console is galvanized to the best protection against rust. Overall look to assembled mechanical construction is photographed on Fig. 2.

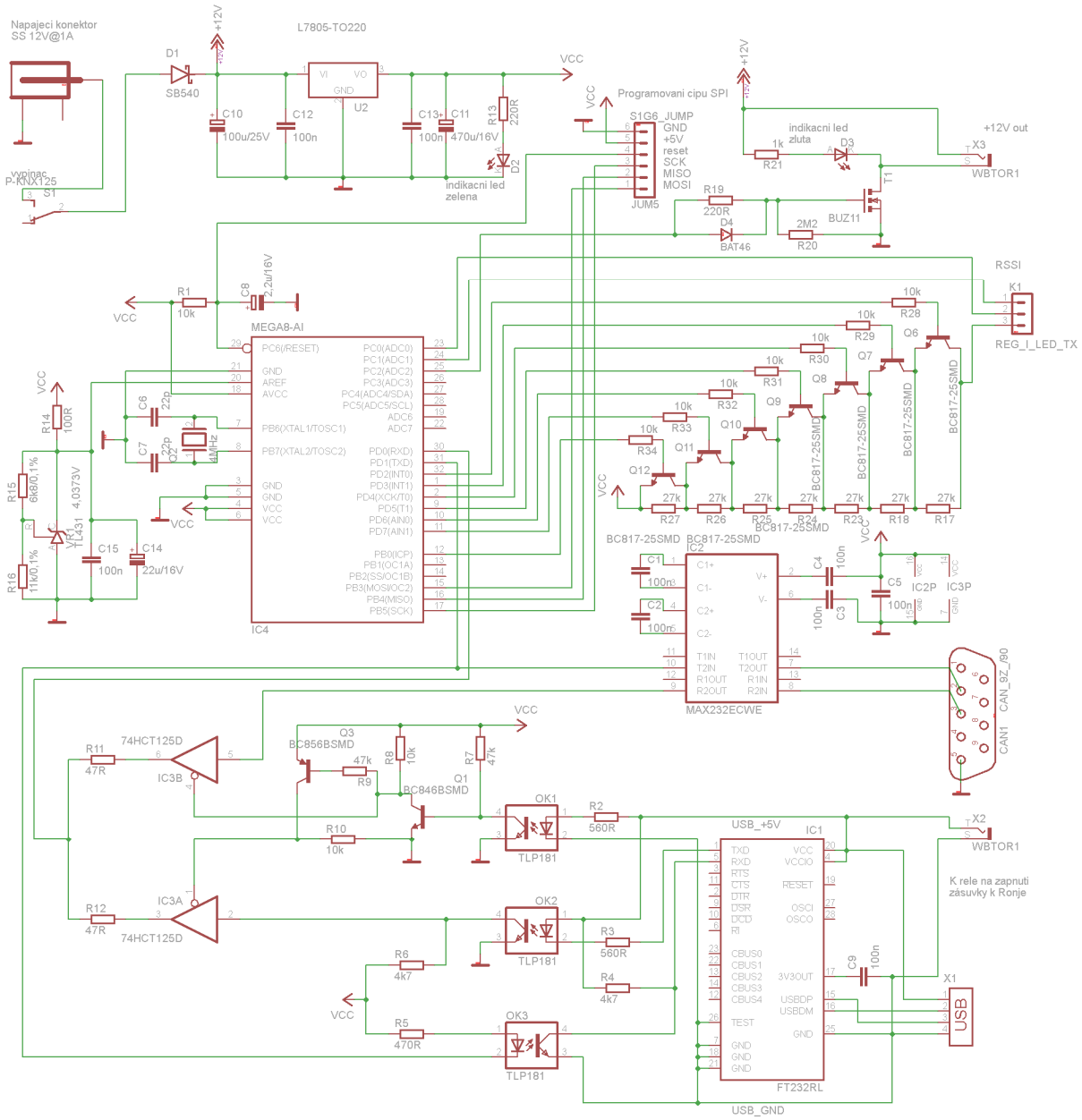
Fig. 2. Overall look of assembled mechanical construction.

V. Conclusion

Modification the Ronja expanded possibilities for different kinds of measurements at the Ronja and improved working with the entire device. The Ronja will very well serve students in the lessons in optical network laboratory. Where they will try to work with the Ronja, its behavior in the limit conditions and affect function of Ronja by various external influences. Students will try complex problems of wireless optical transmission in practice.

Appendix A

Wiring Diagram of Measuring Device for Laboratory Needs



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