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**DIGITAL DATA TRANSMISSION
USING LOW VOLTAGE POWER LINE**

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Low voltage power line as the transmission medium

Interaction between the power line components influents data transmission possibilities.

- Power line impedance
- Disturbances
- Standing waves
- Transmission range

Power line impedance

- Big range of the network impedance changes for the given frequency.
- Power line works as filter.
- Correct data transmission when the voltage output level of the transmitter is not far to the voltage input level of the receiver. It can be achieved when the filter attenuation is low.
- Low attenuation when high value of the parallel filter impedance. Power line impedance might be too low to get connection.

$$levelU = 20 \log \left(\frac{U}{1\mu V} \right) \quad Att = 20 \log \left(\frac{U_{out_{trans}}}{U_{in_{rec}}} \right)$$

Distortion Sources

- Lighting dimmers
- RTV equipment
- Electronic power supply units
- PC computers
- Compact fluorescent lamps (ballasts)
- Power electronic converters
- Switches, small universal motors, fluorescent lamps.

EMC filters reduce distortions but the power line impedance in the transmission band decreases.

Standing waves and transmission range

- In Home Automation wave phenomena can be neglected. Transmission range might be up to tens meters.
- In PLC (Power Line Communication) installation - transmission band is in MHz - when the receiver is in standing wave node receiving signals is impossible. Transmission range might be up to several hundred meters.

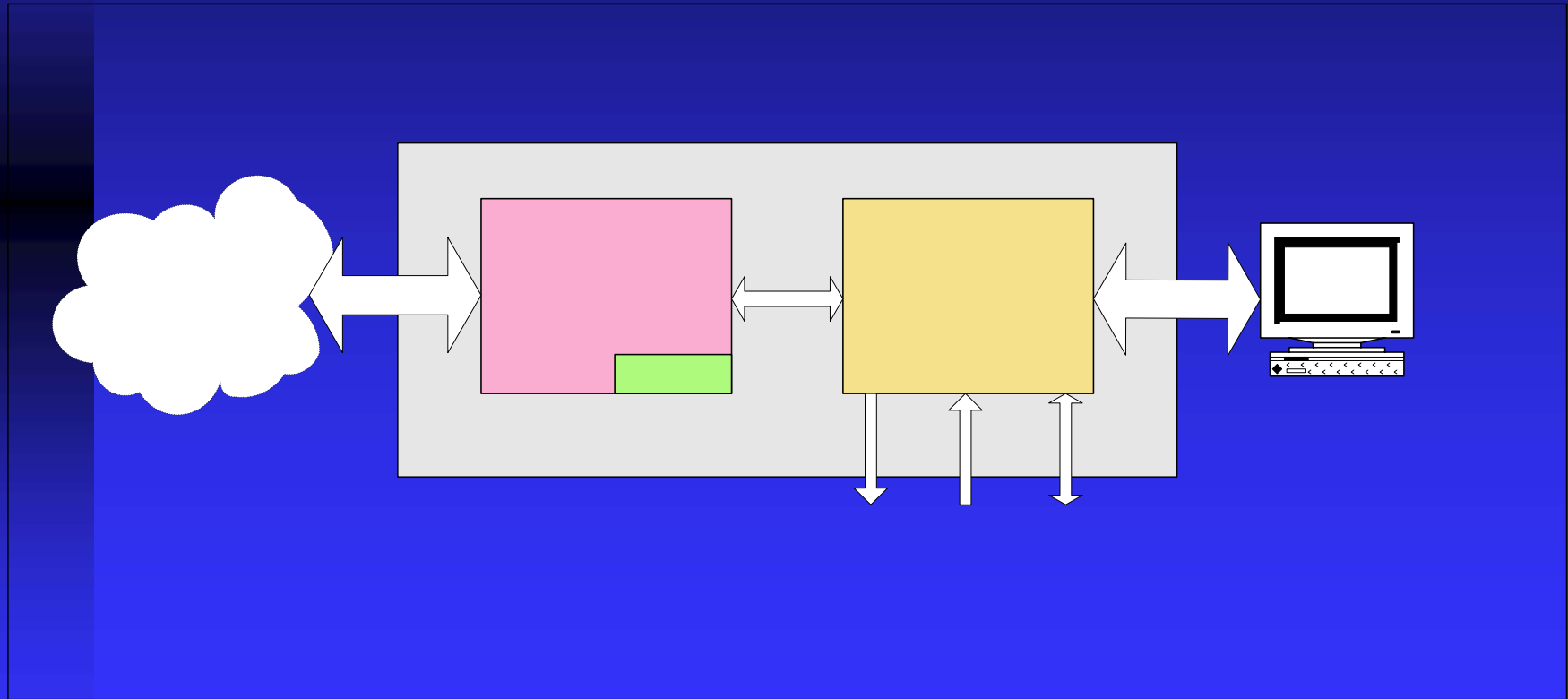
Choice of the transmission system:

- price of the system,
- control equipment complexity,
- quantity and kind of the necessary external elements,
- transmission quality.

Transmission system has to be in conformity with the European standards, especially with EN 50065.

Block diagram of the transmission device

SNAP – Scalable Node Address Protocol, SPI – Serial Peripheral Interface, PSU – Power Supply Unit



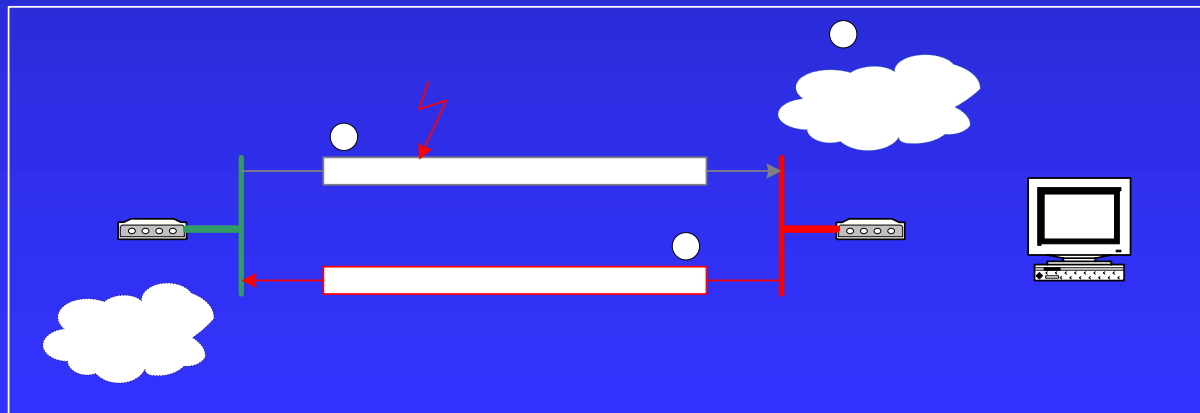
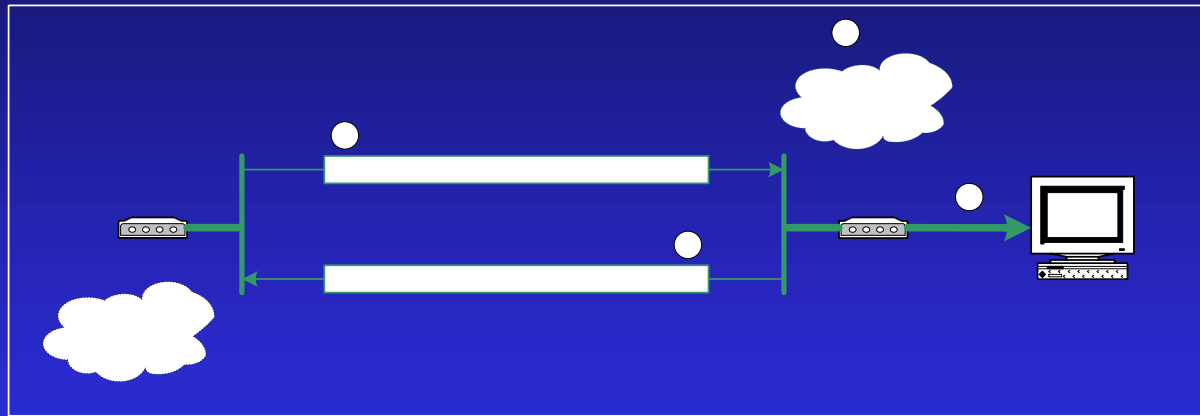
Prototype transmission device

- Prototype device consists of two pieces: analogue modem built on the base of the transmission module AVT-5085 and digital controller built on the base of the microcontroller ATMEGA8.
- The software for the controller was designed with the assembler AVR and Atmel programme AVR Studio 4. To achieve higher speed it was divided into several folders. Data are read and written through the serial port USART (bus RS-232C). The communication between the receiver and transmitter is realised through “virtual serial port” with the SNAP protocol. The “repetition mechanism” is also included.

Data Transmission

A) without distortion, B) with data package distortion

CRC – Cyclic Redundancy Check, ACK – Acknowledge Character,
NAK – Negative-Acknowledge Character DTE – Data Terminal
Equipment



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A) TRANSMITTER

SNAP

Data Transmission (cont.)

Another possible distortions:

- to high attenuation during data package transmitting,
- distortion of the ACK package,
- to high attenuation during ACK package transmitting,
- distortion of the data package and to high attenuation during ACK package transmitting,
- distortion of the data and ACK packages.

Tests results

- Tests were carried out in the one-family house.
- Sockets were supplied from single-phase line.
- First results – negative because to high signal attenuation.
- Identification of the low impedance loads:
 - RTV equipment: TV sets (input filter with teen-nF condenser), satellite tuner (electronic PSU),
 - compact fluorescent lamps with EMC filter.
- Any of the domestic appliances (fridge, mixer, mincer, coffee-mill) had negative influence into correct data transmission.
- After separation of the low impedance loads with the reactor, results were positive and all data were transmitted.

Conclusion

- Transmission speed in Home automatics – depends to how many bytes of data have to be send. Usually from several to tens bytes. Transmission process consists of some configuration bytes, data bytes and “shake-hand” information from the receiver.
- In the described case number of the data bytes was limited to 8, but the package might be increased. SNAP protocol is enough flexible to do it. Before any changes, there should be taken under consideration, that there is applied asynchronic transmission and that there exists any synchronization signal. Transmitter and receiver have own non-synchronised clocks and differences between them might be neglected only when the number of data bytes is small.
- Because of the main advantage – lack of the additional wiring - the low-band transmission can be applied in Home Automation and in lighting control in buildings.