REMOTE CONTROL SYSTEM WITH ETHERNET INTERFACE

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ABSTRACT

This paper deals with remote control system which is used for remote control and monitoring of various devices. Control system is communicating with master system (personal computer) using Ethernet interface. This construction can take the place of watchdog of network devices.

1 INTRODUCTION

At the beginning there was an idea of remote control system which will be able to reset several local area network devices such as modem, access points and wireless clients. There was a need of temperature measuring and ventilator control also. Finally tiny and universal device which can be used in many applications has been developed.

Main features:

- 5 remote controllable 250VAC/10A relays
- 4 optically isolated digital inputs
- 4 optically isolated digital outputs
- Input for DS18B20 digital thermal sensor
- Fullduplex IEEE 802.3 10Mbps Ethernet interface
- Atmel AVR microcontroller with 16MHz clock speed
- Single power supply DC 8-30V

2 HARDWARE

System is based on Atmel AVR family microcontroller. Prototype contains ATMega162 MCU with 16K-bytes of in-system FLASH, 1K-bytes of SRAM and 512 bytes of EEPROM

running at 16MHz.

The fundamental part of system is Ethernet controller. There are several possibilities how to implement it into the system. One is use of a microcontroller with integrated Ethernet interface such as DS80C400 by Maxim/Dallas. But this kind of microcontrollers is not retailed widely and is not cheap also. Another way is use of standard Ethernet controller (used in network products) connected to standard and cheap microcontroller. Due to demand of simplicity the controller should work in 8-bit mode and should be possible to connect it with MCU using address and data bus. Two types of circuits are suitable for this application – RTL8019AS by Realtek and CS8900A by Cirrus Logic. The first mentioned circuit has been widely used in ISA network cards, it is very popular in many embedded applications at this time and it has been used in this system.

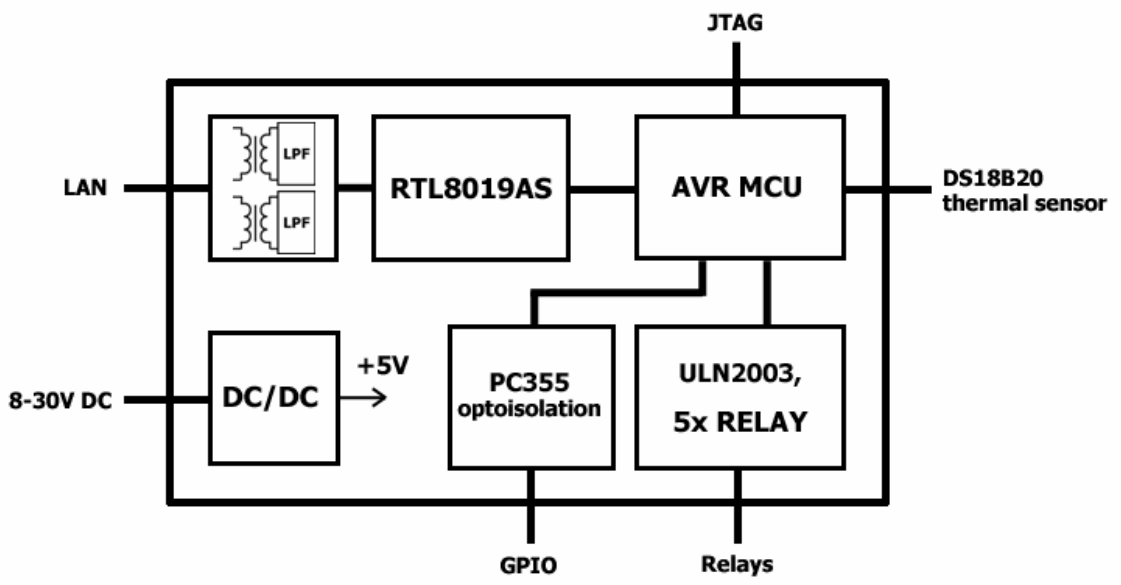

Fig. 1: *Control system block diagram*

The block diagram of system is displayed in fig.1. Circuit requires a regulated 5V DC power supply. This is provided by step-down switching regulator MC34063. The Ethernet controller RTL8019AS is connected to Atmel AVR microcontroller using address and data bus. RTL8019AS contains all digital and analog circuits except filters and isolating transformer. Therefore FB2022 transformer with built-in low-pass filter is used.

Input and output lines are created from one port of MCU, optically isolated and connected to I/O connector.

Relays are controlled using another MCU port over ULN2003 darlington transistor array. Relay's contacts are connected to demountable terminals.

There is one digital I/O line which provides the One-wire interface for DS18B20 thermal sensor. There is possibility of setup any relay to switch on or off depending to measured temperature.

3 SOFTWARE

Software can be divided into two parts – remote control system firmware and PC remote software. We will discuss firmware first. It was developed in AVR studio and written 100% in AVR assembler. It includes RTL8019AS control functions and all needed communication protocols (ARP, IP, ICMP, UDP, TCP). Firmware was developed using RTL8019AS+ATMEGA162 evolutional board displayed in figure 2.

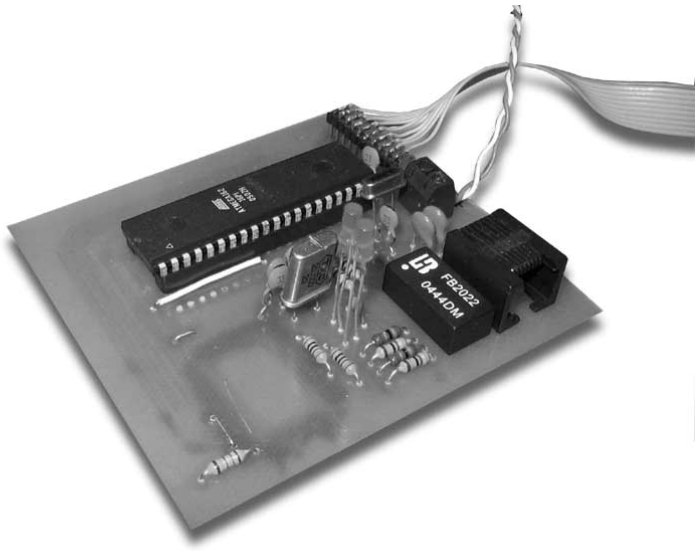

Fig. 2: *RTL8019AS+ATMEGA162 evolutional board*

3.1 ARP, IP, ICMP

The basic protocol which has to be implemented first is the Address resolution protocol (ARP). It provides relation between device's hardware address and its Internet protocol address on Ethernet network. Every Ethernet device has unique hardware address assigned by manufacturer. For network structure, routing and other possibilities there is so called internet address which is unique for every device but only within local network. When sender want to send a packet over Ethernet to recipient it has to determine recipient's hardware address. The broadcast ARP packet is send and recipient with required internet address replies with its hardware address. This ARP broadcast is also used for so called ARP watchdog function. When no ARP packet is received within selected timeout then state of selected relay is affected. This feature can be used for protecting wireless bridges against "freeze" when server is sending ARP broadcast packets.

Internet protocol (IP) provides a middle layer for other protocols such as UDP or TCP for transmitting blocks of data called datagrams from sources to destinations, where sources and destinations are hosts identified by fixed length addresses. The internet protocol also provides for fragmentation and reassembly of long datagrams, if necessary, for transmission through "small packet" networks.

Internet control message protocol (ICMP) need not be implemented but it is eligible to implement ICMP echo reply (also known as ping).

3.2 UDP, TCP

The easiest way to provide interaction with remote control system is implementation of User datagram protocol (UDP). This protocol provides a procedure for application programs to send messages to other programs with a minimum of protocol mechanism. The protocol is transaction oriented, and delivery and duplicate protection are not guaranteed. Then special application has to be written for communication with device.

Another way is implementation of Transmission control protocol (TCP). This protocol includes datagram delivery acknowledgement and duplicate protection mechanisms. Its implementation in microcontroller is not as easy as implementation of UDP due to RAM limitations. With TCP there is possibility of implementation of Telnet and/or HTTP server for communication with master system.

3.3 PC SOFTWARE

Special application for communication with control system has been written. It communicates over UDP and it has been developed with Delphi 6 Personal edition. There is possibility of monitoring and setup of all features such as digital inputs and outputs, relays states, temperature, ARP watchdog and "temperature relays". See figure 3. Several variants of this software can be also created in PHP, Perl or C in Linux of course.

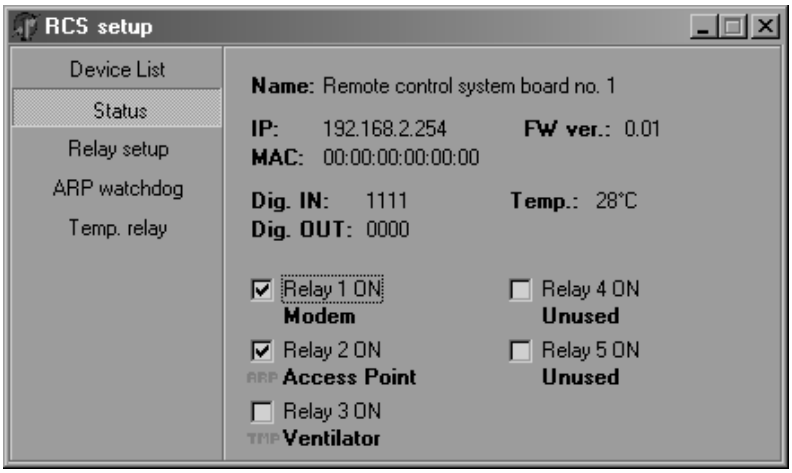

Fig. 3: *Control application*

4 CONCLUSION

The tiny and cost-effective remote control system with Ethernet interface was developed in very short time. All described features have been implemented except TCP which will be implemented together with Telnet in future. Device has been used as watchdog of network devices but due to its universality it can be used in many other applications.

REFERENCES

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