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MODEL OF A TERMINAL NETWORK DEVICE BASED ON A SINGLE-CHIP MICROCONTROLLER AND ETHERNET INTERFACE

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ABSTRACT: *Model of a terminal network device based on a single-chip microcontroller and Ethernet interface: In the present work, a training model of a terminal network device based on a single-chip microcontroller and Ethernet interface is built, allowing the implementation of various functional tasks:*

- *reading of digital and analog sensors*
- *relay output control*
- *visualization of information with digital – alphanumeric display*

KEY WORDS: *Ethernet based end devices, Models, Sensor reading, Stand*

1. Introduction

Ethernet was originally based on the idea of communicating with computers via a shared coaxial cable acting as a data carrier. The methods used show some similarities with radio systems, although there are fundamental differences, such as the fact that it is much easier to detect problems in the cable system than in a radio transmission. The common cable provides communication channels similar to the terrestrial ones ("Ether"), whence the name "Ethernet" - terrestrial network.

Unlike Ethernet, the Internet is a computer network that connects several networks. Internet is an abbreviation of Internet, or literally translated into Bulgarian – Internet. As a proper noun, the Internet is a publicly available internationally connected system of computers (along with the information and services they offer users) that uses the Transmission Control Protocol (Internet

Protocol) TCP/IP language. So, the largest internet is simply called the Internet. The process of connecting networks in this way is known as internet working.

WEB is an acronym for the World Wide Web created by Sir Tim Berners-Lee in 1989. and is itself a system of related documents accessible via the Internet. It originally originated as a document exchange network, but nowadays there are far more applications.

Definitions of these general terms are introduced to clarify that, although widely used, the term web-based end devices are not entirely accurate when used for automation systems.

The rapid development in recent years of the circuit - technical part and its miniaturization, as well as increasing reliability both physically and logically, have introduced and increasingly impose network solutions in the construction of both centralized and distributed management systems [1, 2, 3].

2. Schematechnical solution and software providing a stand for examination of Ethernet based devices

Application of Ethernet based on end devices

Despite its many advantages, Ethernet networks are currently not directly and completely suitable for industrial environments due to the nature of communication traffic processing. Inbound traffic, for example from an industrial fieldbus network, is usually time-limited and therefore requires real-time service, which Ethernet is unable to provide. In order to be able to use Ethernet networks in an industrial environment and to eliminate the need for traditional complex industrial communication systems, it is necessary to ensure the following requirements:

- Real-time support for cyclic traffic should be less than 1ms;
- The delay time should not exceed 1 ms;
- Dynamic real-time configuration of channels with guaranteed performance (Quality of Service – QoS);
- High transmission capacity (100 Mbit/s full duplex);
- Have real-time clock synchronization that can be used by applications or operating systems;
- It is possible to remotely maintain industrial applications via the Internet;
- Maintain multiple real-time logical channels from each node;
- Real-time support for standard UDP/IP internet traffic.

— Support for existing non-real-time TCP/IP and UDP/IP standards for Internet traffic without disrupting real-time traffic.

Although standard networks and network devices do not guarantee the above conditions, it is possible to develop an automation system in an Ethernet environment. Processes in which the variable value of the net delay introduced by packet traffic has no effect (the value of the smallest time constant in the systems is disproportionately greater than the possible time delay formed by the communication) can be monitored and managed without the use of specialized software and hardware, and only with the standard methods of the Internet protocol IEEE 802.3. This paper examines precisely such systems [2, 4].

Overview and analysis of existing similar projects and solutions

Existing similar solutions:

The review of the existing solutions on the Internet and the specialized literature revealed many examples of different Ethernet based end devices, both very specialized and more general purpose.

Service Ltd.:

This mini web server PIC-MINI-WEB was developed by the Varna company Service Ltd. The board has a PIC18F25J10 microcontroller with 32KB of programmable flash memory and allows it to be programmed via a TCP-IP connection. In addition, the board also has 128KB of flash memory available to store data for web pages. The disadvantage here is the high price of the product.

HA7Net:

HA7Net is a product that aims to simplify the integration of distributed 1-Wire networks in various applications or systems. HA7Net allows the efficient use of standard Ethernet network products to build the backbone of a 1-Wire sensor system. The advantages here are: security, professional industrial performance, and as disadvantages can be mentioned: high cost, impossibility of hardware changes, as everything is complete and closed, which makes it unsuitable for the purposes of my research.

In the end, the device I present here has a technology very close to 1-Wire, but the main difference is that separate wires are needed for information transmission, power supply, etc.

Schematic solution and software stand for research of Ethernet based devices

Tuxgraphics – AVR WEB server

It was developed mainly for methodological purposes and as a tool for hobby automation. The entire project is open source and allows with relatively limited

resources to implement various hardware and software solutions for Ethernet end devices (Fig. 1). Block diagram of AVR WEB server is shown on Fig. 2.

Available in both SMD version and standard DIL enclosures. The SMD version is delivered assembled and tested, and the standard one is an assembly kit.

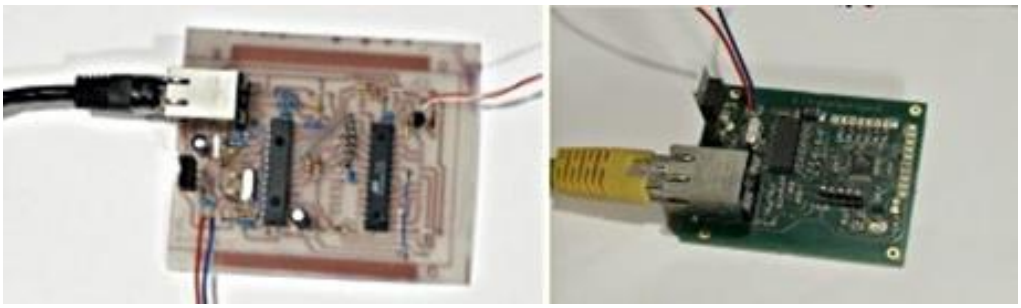

Fig. 1. Tuxgraphics – AVR WEB server

The hardware includes:

— ENC28J60 Ethernet controller with SPI interface, which is easy to use by any microcontroller;

— Voltage regulator 3.3 V;

— Disconnecting transformers and functional LED indicators built into the RJ 45 network connector;

— ATmega168 – 8-bit CMOS microcontroller with low power consumption based on AVR RISC architecture.

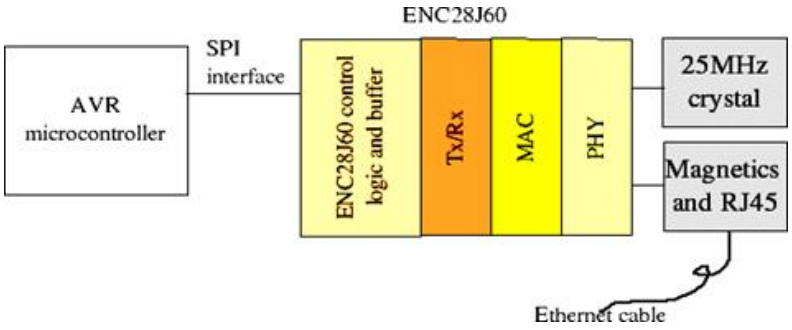

Fig. 2. Block diagram of AVR WEB server

This solution was chosen as the basis of the work due to the good price/performance ratio and the open license for use.

The relatively good input-output capabilities of the single-chip controller of Atmel – Atmega168 allow to realize with minimal hardware additions the following end devices with Ethernet interface:

— Reading a combined temperature and humidity sensor via a serial interface similar to 1-Wire technology;
— Relay output control;
— Visualization with alphanumeric indication;
— Reading an analog pressure sensor with an additional amplifier.

When developing the necessary software, with clear comments on the individual modules, it is possible to achieve the set methodological goals.

For the purposes of our work it was necessary to provide programmatic reading of the sensors, and the visualization of the obtained results can be presented at a low and high level [1, 2, 3].

Low level visualization

Choice of programming language – Programming language C was chosen because the code that is generated can be optimized in volume and speed (the microprocessor used in this thesis has 16KB of flash memory). C is a general-purpose programming language, a block-structured and procedural language that allows bitwise access to hardware, which is typical of low-level languages. Available to a very wide range of platforms, from built-in microcontrollers to supercomputers, which is another factor for its selection in order to solve the tasks in this work.

High level visualization

When it is necessary to use larger graphics capabilities or to manage several objects, it is necessary to develop an operator interface that cannot be located in the controllers due to the large amount of required RAM and machine resources. In this case, the visualization software is installed on a separate computer or dedicated server. This external software can be developed using standard web page design software. The PHP programming language and the MySQL relational database were used to implement the website, which will be used to display high-level results.

3. Conclusion

The stand for research of Ethernet based devices developed in the present work is a set of separate modules, through different combinations, which provide the methodological goals set in the assignment. These modules are designed to connect directly to each other with a minimum of rules.

The work has developed sample software designed for management and research of individual modules, but the stand is open for changing existing software modules and implementing new ones.

With the applied hardware and software solutions after the development of detailed methodological manuals the following methodological goals can be achieved:

— study of μC Atmega 168;
— study of single-chip Ethernet controller ENC28J60;
— examination of a digital sensor with a serial interface;
— visualization of a digital sensor in an Ethernet environment;
— study of the parallel interface to the LCD display;
— Terminal device management in Ethernet environment;
— influence of network traffic on the net delay in Ethernet management;
— The system is open programmatically and schematically for further development.

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