New Possibility for Building ff Temperature Control, Based on One-Wire Micro Lan of Dalas Semiconductor

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Abstract. All special features of the industrial net standard, as well as the principle of building and the topological features of 1-Wire have already been systematized. On the other hand, there is an exact analysis of all advantages and disadvantages that appear in progress of exploiting it in systems for automation. The new system for temperature control in silos is already developed and it is based on the 1-Wire Micro LAN и Visual Basic.NET. New correlation methods are available and they ensure the quality control of the product's quantity. As a result of this, the reliability of the system is higher, the diagnostic, the interactivity and the system maintenance are improved.

Keywords: temperature control, 1-Wire, Micro LAN

1 Introduction

The successfully development of each nowadays existing company would be impossible, if it did not dispose of integrated computer systems and technologies. A very important part of these kinds of systems are nets for data collection, information exchange, maintenance of the technological equipment and finally the control of the processes, including the production. All requirements of the industrial communication nets have their own differences, based on the field they are appropriated to. Very important characteristic of this type of net is to dispose of the following abilities: being high adaptively, stability, economical cost price, as well as possibility for modernization without disturbing the functional parameters of the system. There are different types of constructing factory communication nets, connected to the tasks that have to be solved. The communication net that works with only one conductor was developed by the American company Dallas Semiconductor Corp. in the end of 90ties. It was named 1-Wire. According to the already existing documentation this interface should be disposed to three main fields of exploitation:

- Devices in special packages of Micro CAN for solving the problem with the identification, transfer or converting the information (technology iButton),
- For programming the built in memory in the integral components,
- At the systems for automatic maintenance of the processes (net technology with 1-Wire).

The offer that firstly appears on the world market as been used for a very long time and this is the reason of its high popularity among the consumers. The second one successfully ensures easy changeover of the functions of the semi conductive components with less inner connections, while the systems based on the 1-Wire – technology are still in shadow. At the beginning of creating this interface the fact above had to be explained with the not enough variability of components, which had to ensure the development of nets in the automatic fields. In the last couple of years this fact definitely changed and this gave the possibility for different applications in the field for automatic systems in the factories. The nowadays research is to improve the application of 1-Wire nets in the automatic systems in the factories.

2 Micro LAN - net parameters

It is based on the application of 1-Wire interface. All components of Micro LAN net have a built in network controller, that ensures the work in a net of all devices. This fact enables the possibility of building a distributive system for collection, processing and management of information. This system corresponds to the highest requirements of the present day. It also ensures effective and handy work of the controlled complex. Finally this system allows the accomplishment of remote monitoring and management of processes, when a notebook or a mobile phone is available. The miniature local net (Miniature Local Area Network-Micro LAN) is a net type for digital exchange of data in one-way-conducting interface. (Fig.1)

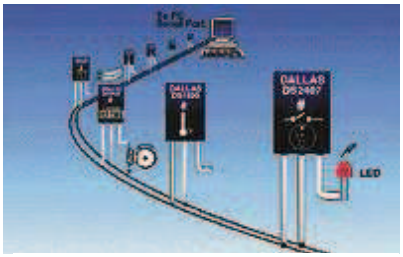

Fig. 1. Communication network Micro-LAN

The net provides for cheaper exchange of information between the computer and the involved in the net devices, supported by one-way-conducting interface.

This type of net is based on the "intelligent"sensors for temperature, humidity, counters, GPIO etc., with high integrated specialized microprocessors. Basically each sensor is unique factory-lasered and tested by the 64-bit registration number, by which the main computer recognizes each concrete sensor in the net and could possibly turn to it anytime - (Fig.2). The industrial communication net Micro LAN could be built between a Personal Computer (PC) and the components of the 1-Wire interface, that are appropriate to the protocol. The net disposes to a practically unlimited space for addresses and ensures rapid work till 300 without the recapitulations. A very prospectively direction is the usage of pocket computers (or PDA (Personal Digital Assis-

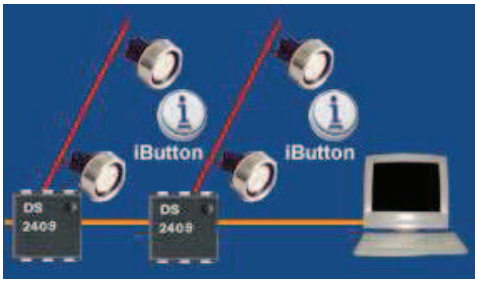

Fig. 2. Organize Micro LAN with micro couplers DS2409

Fig. 3. Attendance Micro LAN with PDA

tant)- Fig.3, based on the well known platforms PalmOS, Handspring and WinCE/PocketPC for maintenance of the one-way conducting components, as well as for those working in the environment of 1-Wire. Connecting the PDA to the 1-Wire requires the assistance of specialized adapters for consequent port. This approach is mostly rational for the organization of autonomic and mobile 1-Wire systems by the moment. Micro LAN uses architectures with one master and may slaves devices. Each factory microcontroller with a universal asynchronous port UART or PK with speed of data processing 115.2 Kbit/sec could play the role of master.

For the accomplishment of a net digital connection should be used one conductor for data and one for ground connection (Fig.1). If there are not many involved devices Micro LAN, it could be applied a kind of rim architecture with connecting all devices in one common highway mainly with tree structure. The main Highway of Micro LAN could be switched by a special controller (as well as by COM, USB or RS232 port) to the master. In this way the computer commits the role of a server in the miniature local net. The management of the networking is ensured by a special software packet, based on Visual Studio 2005, Visual Basic.NET.

The information exchange in the net could be managed by a program. A mater of the net asks the "knots' of net and by the received results embarks one or another activities. If the PC is equipped with a few COM ports, each port provides building pro one of this type of net, which increases the productivity and range of the net.

Ensuring the reliability of data exchange by MicroLAN net in condition of lower stability of the electrical contact the processing is accomplished in separate packets of data. Each packet ends with a control sum, which allows the master to take care immediately of the already received information and to register the errors. Micro LAN has standard CMOS/TTL logical levels. The data exchange could be accomplished in each direction, but at one defined moment – only to one device. Actually the processing of data is asynchronous, serial and semi duplex. The Micro LAN devices have the ability to be supplied the net cable. In each device there is a built in 1-semi-period rectifier, which supplies the inner condensed fluid with capacity of 800pF. It enables the supplement by logical 0. This way of supplement has a specific name parasite power. All devises, intended to work in Micro LAN net has a built in net controller. This allows the building of distributive system for collection of information, using only one common way for data to the master. Each device in the Micro LAN net has an identification number.

What is actually the logic of the device work in Micro LAN net?

The work protocol of the devices is a kind of a structure with many levels. Each level is intended to execute very definite functions. The device work in the Micro LAN net actually modifies the first four levels of this structure. The other levels functioned on the level of file structure in the micro scheme memory.

Physical level - At this level are modified the electrical and logical voltage levels and also the common contemporary parameters of the exchange protocol of Micro LAN net.

Connection level – On this level should be defined the main functions of net connection. This level ensures all functions that are connected to the data collection and data processing. After transferring the impulses for presence it gets on a net level.

Net level – On this level should be fulfilled the identification of the devices of Micro LAN and the availabilities for getting the network connection. The unique factory - lasered number master finds the presence of all slaves in the common rim and also confirms their belonging to the Micro LAN. All commands based on the identification numbers of the obeyed devices enable the one of the most important parameters o the Micro LAN net-namely the permanent changing structure of the net. After sending this type of command and receiving and processing of data it gets on the next level- transport level.

Transport level – On this level should be accomplished the data subscription and data reading of the micro schemes.

The net devices are intended to work at unstable conditions. The contact between the master and each device could be disturbed in each moment and also restored after the defined period of time. Obviously data stays available and do not disappear. The micro schemes in the Micro LAN memory do not keep the data in one common massive. The whole data massive is broken up on separate sites. Avoiding errors, when reading data, is enabled by the following scheme: after the first processing period each site accomplishes processing of a controlling sum, which is formed from the previous data by a specific algorithm. If two values are one and the same, than there must be one or several repetitions of the data reading and the controlling sum. When the controlling sum I s the same, then the data is true.

3 Temperature method for defining the quantity of the grain in the silos

Providing the control and the exactness of the grain in presence, which is saved in the firms` silos, is from higher priority to the National service of grain and fodder in connection with the Ministry of agriculture and wood resource or regulation of the grain on the market. Each owner or tenant of a store keeps all documents that are connected to the buying out of the grain, its preservation and selling. Each month the owner or the tenant prepares a report, based on all operations, connected to the grain .They include the following information: number of the warehouse capacity, the type of the product,; quantity o the product; all received and sent quantities at one month; the grain presence at the end of the running month; all concluded, but not fulfilled contracts for buying or selling of the grain. [3].

Filling out the reports is lightened by different types of methods that measure the grain in the silos:

- By servomotor, that moves the a reel and a weight, which achieve the grain level
- By ultra voice sensor

The first method has the following disadvantage: the weight could be stacked in the grain and the rope could not stain the strain. The second method requires special con-

ditions of him nearby environment, such as: dash, Exi, diameter of the silos. That's why they haven't been approved at all. The already used methods have an unsuccessful application and this is the reason to be searched new alternative methods for solving these types of problems. The new method has to ensure the grain presence in the silos.

$$\sigma_{t_{ijk}} = \sqrt{\frac{\sum_{i=1}^{n}\left(t_i - \bar{t}\right)^2}{n}}, \quad (1)$$

Where: t_{ijk} is the temperature of the κ sensor, situated on the j^{th} rope in the i^{th} silo. The number of the measurements n = 24*60/Δ. This defined by the time of discreet management Δt [min] and the continuality of one day and night.
After defined the sensors, which are in thermal contact with grain and others without contact we can calculate capacity of the grain in silos by equation:

$$Q_i = \left(\Pi\frac{d^2}{8} * r_{i1} * l + \sum_{j=2}^{5}\Pi\frac{3d^2}{8}\frac{1}{4} * r_{ij} * l\right) * Hl/100, \quad (2)$$

Where: Qi is capacity of the grain in silos, l –distance between sensors applied on j rope from i silos. Diameter of the silos is named with d, and rij are counts of the sensors from j rope, in active contact with grain. Hl is defined as 75.0 dg/l, which is standard average value of the consistence of the grain.

4 Automated system for controlling the temperature in the silos, based on Micro LAN technology

Fig. 4. Situation of the silos in mill factory.

Based on single conducting net Micro LAN is created simple, flexible and hopeful system for collecting, treating and managing the information for the temperature in the silos for a grain showed on Fig. 4.
The results are used to determine the quantity of the grain in the silos. The system is created according to the scheme on Fig. 5.
The automated system contains the followings components: master: personal computer with operating system Windows XP, iButton: 1-Wire Drivers for Windows, Software, based on Visual coupler DS 2409, DS 1820, and temper sensors DS 1820, block for supply.
The DS2409 Micro LAN Coupler is specialized coupler for creating t-joints in the conduit net Micro LAN. It possesses special resources for supply, analyses and control on the served couplers of the net and options for fast search of the available com-

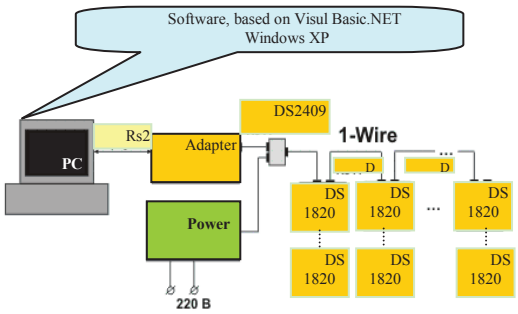

Fig. 5. Organization of the Micro LAN

ponents in the net. With the drivers of the single conduit net of type DS2480, the coupler allows bigger length and bigger number of couplers to the net. Other important characteristics are:

- Low impedance coupler to create large common-ground, multi-level MicroLAN networks
- Simplifies network topology analysis by logically decoupling devices on active network segments
- Conditional search for fast-event signaling
- Auxiliary 1-Wire® line to connect a memory chip or to be used as digital input
- Programmable, general-purpose open-drain control output
- Communicates at 16.3kbits per second Unique, factory-lasered and tested 64-bit registration number (8-bit family code + 48- bit serial number + 8-bit CRC tester) assures absolute traceability because no two parts are alike 8-bit family code specifies device communication requirements to bus master
- Built-in multidrop controller ensures compatibility with other MicroLAN products
- Operating temperature range from -40°C to +85°C
- Compact, low-cost

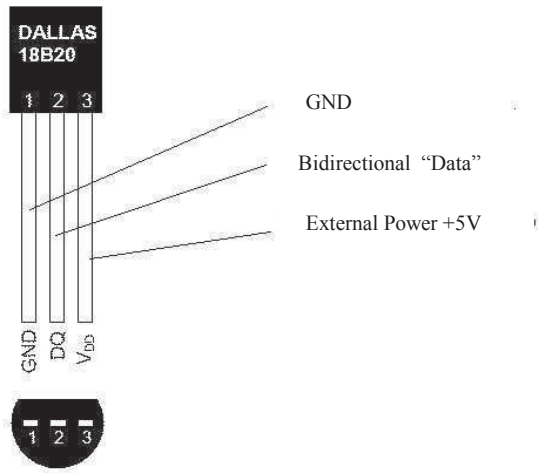

Fig. 6. Pin position of the DS18B20

The DS18B20 Programmable Resolution 1-Wire Digital Thermometer provides 9 to 12–bit centigrade temperature measurements and has an alarm function with nonvolatile user-programmable upper and lower trigger points. The DS18B20 communicates over a 1-Wire bus that by definition requires only one data line (and ground) for communication with a central microprocessor. It has an operating temperature range of –55°C to +125°Cand is accurate to _0.5_C over the range of –10°C to +85°C. In addition, the DS18B20 can derive power directly

from the data line (“parasite power”), eliminating the need for an external power supply. Each DS18B20 has a unique 64-bit serial code, which allows multiple DS18B20s to function on the same 1–wire bus; thus, it is simple to use one microprocessor to control many DS18B20s distributed over a large area. Applications that can benefit from this feature include HVAC environmental controls, temperature monitoring systems inside buildings, equipment or machinery, and process monitoring and control systems.

- Unique 1-Wire® interface requires only one port pin for communication
- Each device has a unique 64-bit serial code stored in an onboard ROM
- Multidrop capability simplifies distributed temperature sensing applications
- Requires no external components
- Can be powered from data line. Power supply range is 3.0V to 5.5V
- Measures temperatures from –55°C to +125°C (–67°F to +257°F)
- 0.5_C accuracy from –10°C to +85°C
- Thermometer resolution is user-selectable from 9 to 12 bits
- Converts temperature to 12-bit digital word in 750ms (max.)
- User-definable nonvolatile (NV) alarm settings
- Alarm search command identifies and addresses devices whose temperature is outside of programmed limits (temperature alarm condition)
- Software compatible with the DS1822
- Applications include thermostatic controls, industrial systems, consumer products,thermometers, or any thermally sensitive system

4.1 Principal operation — measuring temperature

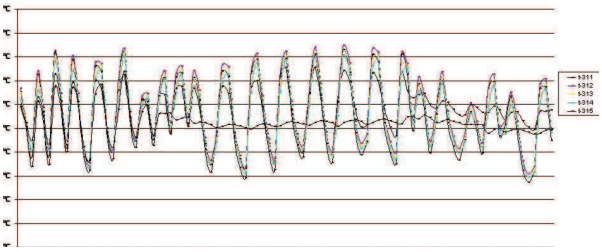

Fig. 7. Graphics of the temperature in the sensors on the 1 rope.

The core functionality of the DS18B20 is its direct-to-digital temperature sensor. The resolution of the temperature sensor is user-configurable to 9, 10, 11, or 12 bits, corresponding to increments of 0.5_C, 0.25_C, 0.125_C, and 0.0625_C, respectively. The default resolution at power-up is 12-bit. The DS18B20 powers-up in a low-power idle state; to initiate a temperature measurement and A-to-D conversion, the master must issue a Convert T [44h] command. Following the conversion, the resulting thermal data is stored in the 2-byte temperature register in the scratchpad memory and the DS18B20 returns to its idle state. If the DS18B20 is powered by an external supply, the master can issue “read time slots after the Convert T command and the DS18B20 will respond by transmitting 0 while the temperature conversion is in progress and 1 when the conversion is done. If the DS18B20 is powered with parasite power, this notification technique cannot be used since the bus must be pulled high by a strong pull-up during the entire

temperature conversion. The DS18B20 output temperature data is calibrated in degrees centigrade; for Fahrenheit applications, a lookup table or conversion routine must be used. The temperature data is stored as a 16-bit sign-extended two's complement number in the temperature register. The main purpose of the system for preserving the grain is a monitoring of the temperature of the grain and preventive control on the supporting: active ventilation or transporting in new silos cells. The economic effect from the looses, because of incorrect preservation is enormous as a result all contemporizing silos economies posses temper monitoring of the preserved grain. Undoubtfully the application of 1-Wire Micro LAN technology increases the hopefulness, simplifies the technological decision and gives new opportunities not only for the preservation but also control on the quantity of the grain. The behavior of the temperature for one temper rope in 3rd silos is showed on Fig. 7.

5 Conclusion:

The proposed temper method for determine the quantity grain in the silos, provides fast effect and cheap distance control with high preciseness in the control and the sum of the grain in the silos of the millers as overcoming the disadvantages of the known analogical methods.
An automated system for monitoring and control of the temperature in the silos is realized, based on 1-Wire technologies from Dallas Semiconductors through Micro LAN communicating net between the components of the system. The system is practically realized in the silos for storage of wheat in the millers in Biala Slatina, the silos for storage of grain in the forage factory in Brashlen (Ruse).

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