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Advanced Energy Metering and Control System

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Introduction

Drastically rising energy production costs, continuously increasing demand for environment-friendly and reliable technologies, require rational and economic usage of energy recourses. This creates objectives to develop an advanced metering and energy control system [1].

Rising energy consumption could be reduced by optimizing the energy supply chain. This can be done in many ways: creating more flexible and universal billing, using real time control of building environment (heating, air conditioning and ventilation, lighting, security, etc.) and increasing measurement accuracy.

There are several automated meter reading (AMR) systems in the market, but they have one common drawback - they are focused only on data collection [1,2].

The new energy metering and control system "Rubisafe Information System" (RIS) developed by AB Axis Industries (Kaunas, Lithuania) offers unique opportunity for efficient energy consumption management. It provides information about the usage of energy distribution network. Using this data load control help to balance the whole network.

By receiving individual consumption values together with appropriate pricing evaluation, multi-house residential customers can regulate their expenses for energy consumption.

Peak period failures can be avoided or their impact minimized by using efficient and an intelligent control system. The main parts of this system are remotely configurable controllers having intelligent load management algorithms.

This system has traffic costs control algorithms for information transfers. Two-way communication (high cost medium) is used for transferring huge amounts of data while primary device data and alarm messages are sent only in one direction by using a low-cost medium (i.e. one-way-traffic, such as SMS or short radio messages).

The company using this system can cut their exploitation costs by initiating two-way communication when the system controller is ready to send the new data or in emergency situations.

Information about the system status and all control functionalities is available online. Flexible billing options, readable statistical data, an emergency alarm system and easy control functions are offered. Energy providers, equipped with such system, could provide hourly meter readings including the remote device status, load control, evaluative price information and energy theft detection. Also, they will able to ensure the system equipment security and authorized access, and also quality of service.

Energy metering and control system

Only the proper system architecture and suitable infrastructure components can realize the above mentioned benefits.

The Rubisafe Information System (RIS) design has been developed by combining different metering, energy control and data transmission technologies, while leaving open ways for future expansion.

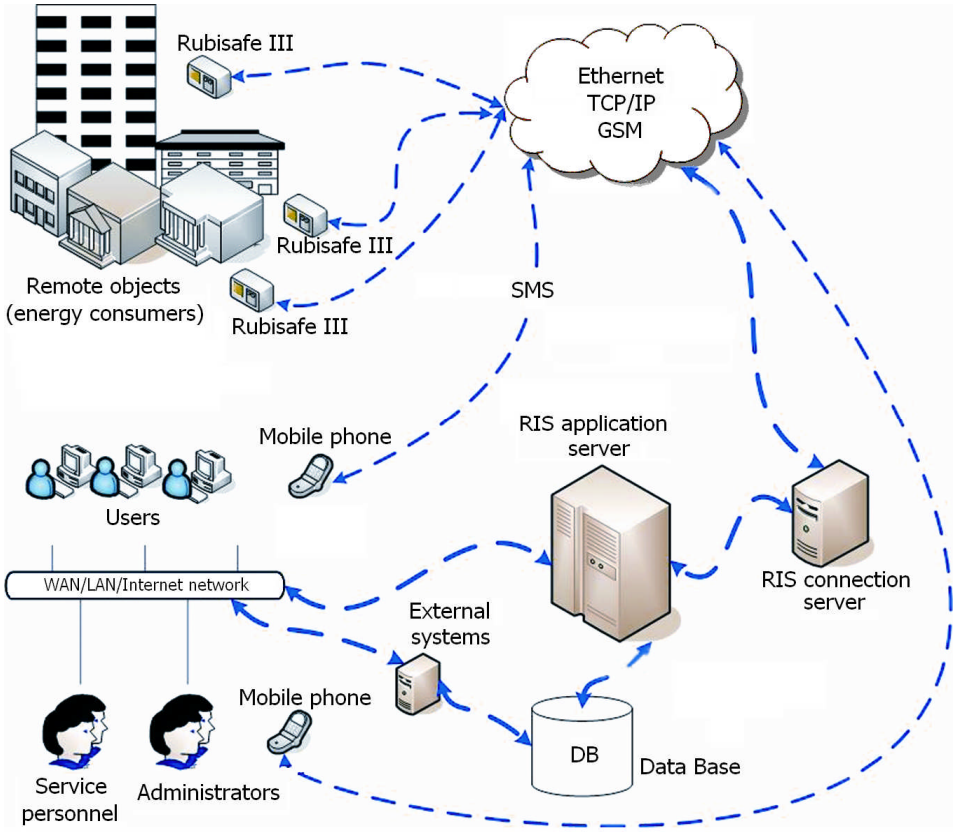


Fig. 1. The structure of energy metering and control system RIS

RIS infrastructure covers the automated meter reading (AMR) system, remote control and data acquisition technologies, advanced and secure networking techniques, distributed network management and web services support (Fig.1). For implementation of these functionalities, lots of different equipment has been integrated into the system.

RIS consists of the following parts:

- remote object;
- system controller Rubisafe III;
- data transmission network;
- connection server;
- application server;
- database;
- interface for external systems;

The remote object contains devices responsible for heating, ventilation and air conditioning (HVAC) of the building, hot water preparation and metering equipment. All these processes are controlled by the system controller Rubisafe III. At the same time, it is a gateway to the system connecting remote objects to the information system using the existing mobile or fixed networks infrastructure (LAN, GSM/ GPRS, PSTN).

The connection server and communication equipment are responsible for the link between the system and the remote object. This part of RIS ensure security and reliability of the transmitted data.

The application server is a user interface to complex data structures stored in the database. It enables monitoring and control functions of the remote object and analyses the incoming data. The application server unites all RIS infrastructure, thus gaining unique and exceptional functions of the system.

Heat energy meters

The heat energy meter influences the main characteristics of the heat energy account and control system, such as method of energy control (dependent on heat meter modification), measurement accuracy and dynamics of energy adjustment.

The main characteristics of heat meters (accuracy, dynamic range, fluid temperature ranges, environment class) have to meet the requirements according to European Standard EN 1434 [3]. This standard describes the requirements for heat meters with various classes of accuracy, dynamic range and environment classes, however in developing modern heat energy account and control systems it is also necessary to take into account the national requirements of heat energy account [4,5] and then to offer heat meters with the highest accuracy (class 1 or 2), wide dynamic ranges (100 or 250) and capable of measuring heat transfer fluid in various heating systems (open, closed, etc.) within the pipelines of various sizes from DN15 to DN200 and higher.

The method of heat energy account and control depends on the modification of the meter which is different depending on the heating system which can be [4,5]:

- closed heating system (requiring 2 temperature sensors in the feeding and return pipelines and 1 or 2 flow sensors in feeding or (and) return pipelines),
- open heating system (requiring 3 temperature sensors in the feeding, return and cold water pipelines and 2 flow sensors in feeding and return pipelines,

Fig. 2. Multifunctional ultrasonic heat meter SKU4

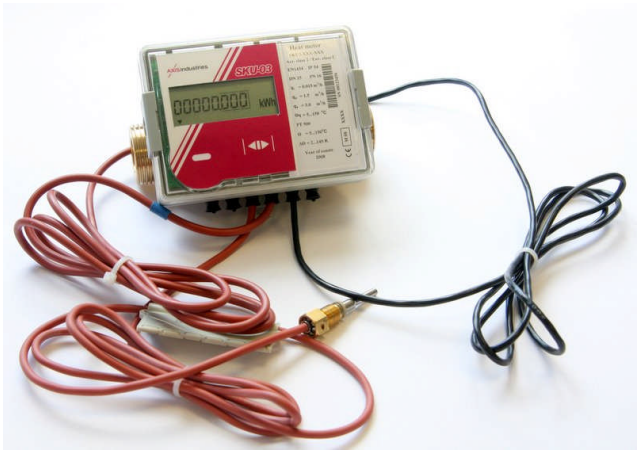


Fig. 3. Compact ultrasonic heat meter SKU3

- heating system with the boiler (requiring 3 temperature sensors in the feeding, return and cold water pipelines and 1 flow sensor in feeding pipeline and 1 or 2 flow sensor in boiler heating contour pipeline),
- cooling systems (requiring 2 temperature sensors in the feeding and return pipelines and 1 or 2 flow sensors in feeding or (and) return pipelines).

However, the new developments in heating systems sometimes not only require to offer heat a meter for complex combination of heating systems mentioned above, but also to provide additional features in meters (option for flow regulation, pulse inputs from the external flow sensor, pressure measurement, leakage detection and data transfer, by using optical, M-bus, CL interfaces or radio modem).

The new battery-powered ultrasonic heat energy meters SKU-4 and SKU-3 have been developed and prepared for serial manufacture in AB “Axis Industries”.

Heat meter SKU-3 is a low cost compact electronic device with one flow measurement channel for the ultrasonic flow sensor of size from DN15 to DN50 (Fig.2).

Heat meter SKU-4 is a multi-functional electronic device that has two flow measurement channels for the ultrasonic flow sensor of size from DN25 to DN600 and includes lots of extended features (Fig. 3).

The flow sensors of size DN15 – DN50 of these heat meters are manufactured by using cost-effective moulding technologies (iron cast and brass moulding) [6,7]. The manufacture of ultrasonic transducers for flow sensors, the assembly of flow sensors and testing are performed in AB Axis Industries by using specialised equipment that do not require special knowledge for manufacturer personnel [7,8].

Common features of SKU3 and SKU4 are:

- extended battery lifetime up to 12 years without battery change;
- license-free ISM frequency band radio interface (868.0 - 870.0 MHz);
- M-Bus interface according to EN 13757 standard;
- current loop interface;
- optical interface according to EN 1434 standard;
- additional 2 pulse inputs for flow volume account from external flow sensors;
- option for flow regulation;
- typical accuracy class 2 according to EN 1434 standard;

Extended features of multifunctional heat meter SKU-4 are:

- the maximum cable length from the flow sensor to the electronic box can be up to 100 m;
- configurable type of heating medium;
- up to 3 temperature measurement channels;
- 2-wire or 4-wire connection of temperature sensors PT500 or PT1000;
- additional 2 current inputs for pressure sensors;
- 19 different modifications for heat energy account in various systems (closed, open or combined heating and cooling systems);
- optional 230 V AC power supply;
- accuracy class 1 for flow sensor of sizes DN80-DN600 according to EN 1434 standard;

Energy system controller

AB Axis Industries has developed an energy system controller Rubisafe III (Fig. 4) which is not only a simple central control unit, but also a gateway to RIS allowing different manufactures to use Rubisafe Information System benefits with their technologies. The main features of the system controller Rubisafe III are:

- gateway to RIS;
- fixed and mobile networks support (LAN, GSM/GPRS, PSTN);
- district heating controller;
- AMR master;

- security and personnel identification;
- energy distribution line parameters logging;
- events about emergency situations;
- power fail detection;
- 16 temperature measurement channels (accuracy ±0,5 °C).

The main functions of the system controller Rubisafe III are:

1) Heat system control

One of the most important functions of the system controller Rubisafe III is the control of district heating, ventilation, air conditioning and hot water preparation systems. Without any external modules it can control up to 3 independent circuits (regulation accuracy ±1 °C). The device has intellectual, energy saving regulation algorithms with anti-freezing and anti-boiling protection. Special procedures for periodic equipment (valves, pumps, etc.) testing are installed. Flexible configuration possibilities provide adaptation this device to the existing heating and water preparation systems.

2) Security and authorization

To control the service personnel and their actions by means of the system, the security and authorization module has been developed. By using this function only authorized personnel can access the device or even enter the installation room. Identification is solved by using RFID cards. Card numbers and rights can be set or changed remotely from RIS. All unauthorized attempts to get into the automation room will be reported to RIS.

3) Automated meter reading (AMR)

System controller Rubisafe III works as AMR master reading energy consumption values and storing them for further processing (Fig. 5). It can read and store data from several thousands meters. Two communications with meter mediums are implemented:

- M-Bus interface according to EN 13757 standard;
- Wireless radio interface in license free ISM frequency band (868.0 - 870.0 MHz).

M-Bus interface is used as a unified bus where meters produced by different manufactures can operate.

Wireless interface is required in places where cabling is not allowed. While there is no standard for unified meter communication over the air, several wireless systems working in ISM bands have been chosen. The another advantage of the wireless system is that it has much wider expansion possibilities.

RIS user interface

Specialized software has been developed to simplify complex control processes, making them easy to use and understand regardless of the user qualification. Graphic and user-friendly interfaces help to control heating and hot water preparation processes (Fig. 6a), to monitor boiler rooms and houses (Fig. 6b), read and analyse energy consumption values (Fig. 6c). By using web interfaces, the administrative personnel can remotely access their remote objects (heating systems, energy meters, etc.) any time from any place where internet access is available.

a)

b)

Fig 4. Energy system controller Rubisafe III with the system automation equipment (a) and the heating and hot water preparation unit controlled by Rubisafe III system controller (b)

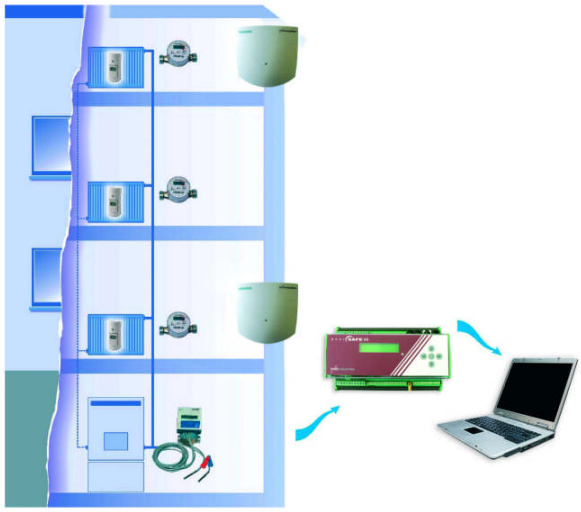
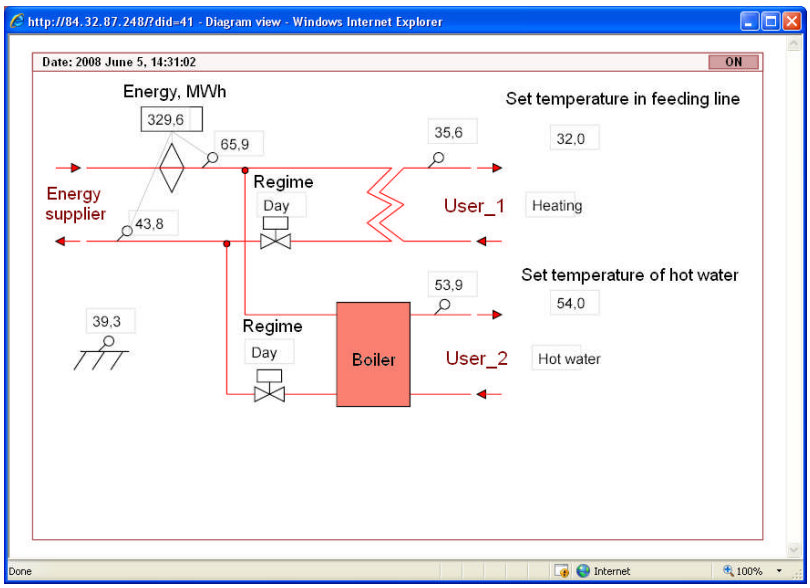
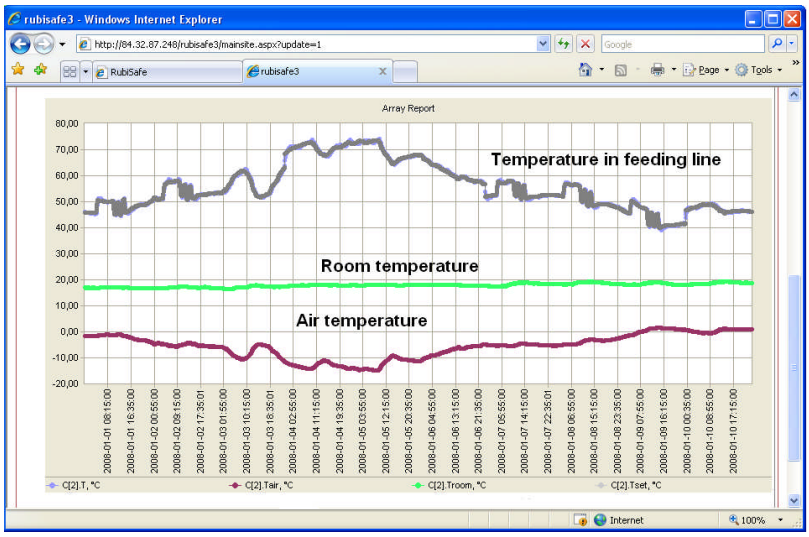


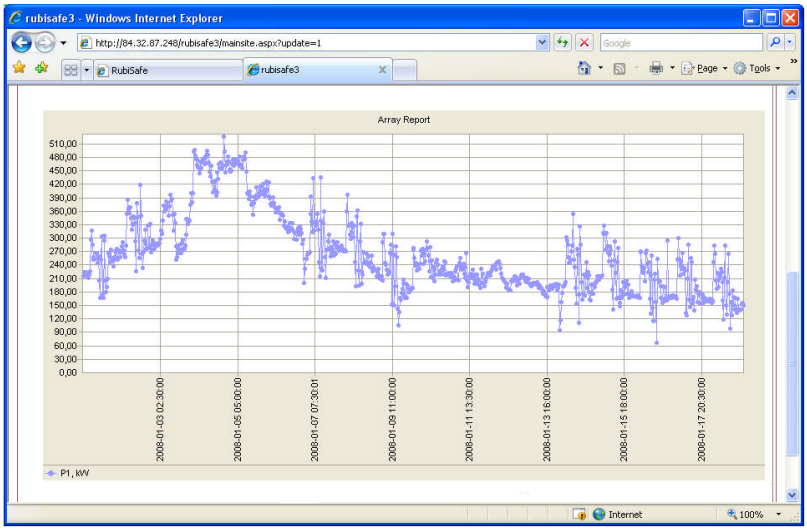
Fig 5. Automated meter reading using the system controller Rubisafe III



a)



b)



c)

Fig. 6. RIS software user interface windows: remote control of heating system parameters (a), heating system parameters data log over the selected period (b) and analysis window of heat energy consumption over the selected period of time (c)

Conclusions

The advanced energy metering and control system RIS (Rubisafe Information System) with the infrastructure has been developed by AB Axis Industries (Kaunas, Lithuania). This product is a result of the long development process that the market has been waiting for. It is expected that such automated control of the heating system could reduce energy consumption up to 30 %, due to the optimal control of temperatures in feeding and return lines [9], building overheating avoidance [10] and implemented consumers' possibilities to control thermostat parameters remotely [1]. The components of RIS infrastructure (Rubisafe III system controller, ultrasonic heat meters SKU-3 and SKU-4, software for Rubisafe application and connection servers) have been prepared for serial production, and some system components are already certified in Russia, Belarus, Ukraine and EU countries. The first products of the RIS has been already installed and being successfully used in Lithuania and Latvia.

Acknowledgements

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The advanced energy metering and control system RIS, which has been developed and prepared for serial manufacture by "AB Axis Industries" is presented. This system is perfect for optimisation of energy consumption (heat, electricity, gas, etc.) as well as for precision regulation, thus ensuring comfortable environment. The infrastructure of heat energy metering and control system and its components (ultrasonic heat energy meters, system controller, specializes user software for data analysis and control) are described. It is expected that such automated control of heating system could reduce energy consumption up to 30 %. The system has been already installed and is successfully used in Lithuania and Latvia. The components of this system are certified in Russia, Belarus, Ukraine and EU countries. Ill. 6, bibl. 10 (in English; summaries in English, Russian and Lithuanian).

В. Памакштис, Ю. Калужявичус, В Пяткус, А. Багдонас, П. Бородичас. Передовая система измерения и контроля энергии // Электроника и электроника. – Каунас: Технология, 2008. – № 7 (87). – С. 93–98.

Представлена передовая система измерения и контроля энергии RIS, которая была создана и подготовлена для серийного производства «AB Axis Industries» (Каунас, Литовская Республика). Система предназначена для оптимизирования потребления энергии (теплоты, электричества, газа и т. п.), также для ее прецизионного регулирования гарантируя комфортную окружающую среду. Детально описана инфраструктура системы управления и учета тепловой энергии и отдельные ее компоненты (ультразвуковые счетчики тепловой энергии, контроллер системы, специальное программное обеспечение для анализа и управления данными). Предположено, что применение такой системы автоматизированного управления отоплением смогло понизить потребление энергии до 30 %. Система уже была установлена и успешно применяется в Литве и в Латвии. Компоненты этой системы сертифицированы для применения на территории Российской Федерации, Беларуси, Украины и странах ЕС. Ил. 6, библ. 10 (на английском языке; рефераты на английском, русском и литовском яз.).

V. Pamakštis, A. Ragauskas, J. Kaluževičius, V. Petkus, A. Bagdonas, P. Borodičas. Pažangi energijos apskaitos ir valdymo sistema // Elektronika ir elektrotechnika. – Kaunas: Technologija, 2008 – No. 7(87). – P. 93–98.

Pristatoma pažangi energijos apskaitos ir valdymo sistema RIS, kuri buvo sukurta ir paruošta serijinei gamybai įmonėje „AB Axis Industries". Sistema puikiai tinka energijos (šilumos, elektros, dujų ir t. t.) vartojimui optimizuoti, taip pat jai preciziškai reguliuoti, užtikrinant komfortišką aplinką. Detalizuota šilumos energijos apskaitos ir valdymo sistemos infrastruktūra bei jos komponentai (ultragarsiniai šilumos apskaitos prietaisai, sistemos valdiklis, specializuota programinė įranga skirta duomenų analize ir valdymui). Tikimasi, kad ši automatizuota šilumos valdymo sistema sumažins energijos suvartojimą iki 30 %. Sistema jau yra įdiegta ir sėkmingai eksploatuojama Lietuvos ir Latvijos miestuose. Sistemos komponentai yra sertifikuoti Rusijoje, Baltarusijoje, Ukrainoje ir ES šalyse. Il. 6, bibl. 10 (anglų kalba, santraukos anglų, rusų ir lietuvių k.).

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