SMARTHOME, COST–EFFECTIVE HOME AUTOMATION SYSTEM

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ABSTRACT

This paper deals with cost-effective home automation system which adjusts the security, cooling, heating, and lighting automatically for comfort, energy savings, and convenience. SmartHome system takes the place of standard security system, and for not much more, greatly increases the value, safety, and efficiency of house or flat.

1 INTRODUCTION

At the beginning of developing of the system, the idea of price friendly available system for the monitoring of my flat was present. The system was developed with demand of stand-alone reliable operation of the equipment and the possibility to monitor and set up it via remote control using internet connection or SMS messages. Design process flow into system with interesting price applicable in various areas. This contribution is not able to describe all features of created system as the topic is very wide. Therefore only the most important were chosen.

1.1 SMARTHOME DESCRIPTION

The SmartHome is an advanced stand-alone cost-effective home automation system that incorporates the powerful Rabbit 3000 microprocessor, FLASH memory, Serial FLASH, Static RAM, protected digital I/O ports, D/A converters, RS-232 / RS-485 serial ports, IR remote control, 1-wire interfaces and 10 Mbit Ethernet port [1].

1.2 SMARTHOME FEATURES

The core of SmartHome forms module RMC3700 produced by company Rabbit Semiconductor. The RMC3700 RabbitCore is the Rabbit3000 microprocessor based core module designed for Ethernet/Internet Applications with 512 K Flash / 512 K SRAM, 4 serial ports, and an extremely small footprint [1]. The RMC3700 module is mounted directly on a motherboard with a single 0,1'' 2x20 dual-row header and can be interfaced with all manner of CMOS compatible digital devices. In this case HTC CMOS circuits were used as they are compatible with TTL logic levels [2]. 32 digital I/O, power and other signals are routed

directly to the motherboard. Built-in low EMI features, including a clock spectrum spreader, practically eliminate EMI problems [1].

SmartHome as motherboard together with connected RMC3700 allows join various peripherals together (see tab.1) and analyse the collected data from input sensors and use them for evaluation and control processes.

Feature	Nm.	Possible peripherals
Output, switch-over relay	16	thermostat - central heating
		thermostat - air condition
		relay control
		light control
		alarm siren
Input (isolated)	32	reed contact, door, window
		fire detector
		button sensor
		current and voltage sensor
Temperature sensor	3÷9	indoor & outdoor temperature measurement
Infra-red remote control	1	command receive and transmitting
		control of AV equipment
RS 232	1	GSM modem control
RS 485	1	
Ethernet 10 Mbit	1	HTML based management
		XML support
D/A converter, 0 ÷ 24V	2	lights dimmer control
		thermostatic valve regulation

Tab. 1: *SmartHome connection features*

2 SMARTHOME SUBSYSTEMS

Block diagram of SmartHome is displayed on the fig.1. The diagram describes SmartHome system formed by several functional blocks. Blocks are connected to the central microprocessor and thereby the centralised controlling system is build [3]. The core of system – microcomputer RMC3700 is placed on separated 4layers printed circuit board. This construction makes possible changes in future in the most comfortable way. Such change can be e.g. exchange of microcomputer module on other one that will be more powerful, with bigger memory. Another advantage is in the fact that the complexity of the big motherboard of PCB is significantly reduced. This solution brings savings in production costs.

SYSTEM HARDWARE DESCRIPTION

SmartHome system requires a regulated +24V DC power source. Control logic supply is regulated to the value of +5 V by step-down switching regulator LM2575. The regulator circuit offers a high-efficience replacement for three-terminal regulators. It substantially reduces the size of heat sink and in this case no heat sink is required. MAX232A circuit is

used as level converter for RS232 interface. Via this interface the GSM mobile phone is connected to the system. Mobile phone provides receiving and transmitting of SMS messages. MAX485 circuit makes possible to communicate for longer distance through RS485 interface. Via SPI interface the MAX548A circuit is connected. This circuit together with power amplifiers fulfils the function of two D/A converters with output voltage range of 0÷24 V. Through these outputs compatible thermoelectric valves can be driven. Alternatively, output voltage reduced range (0÷11 V e.g.) can be used for light dimmers control.

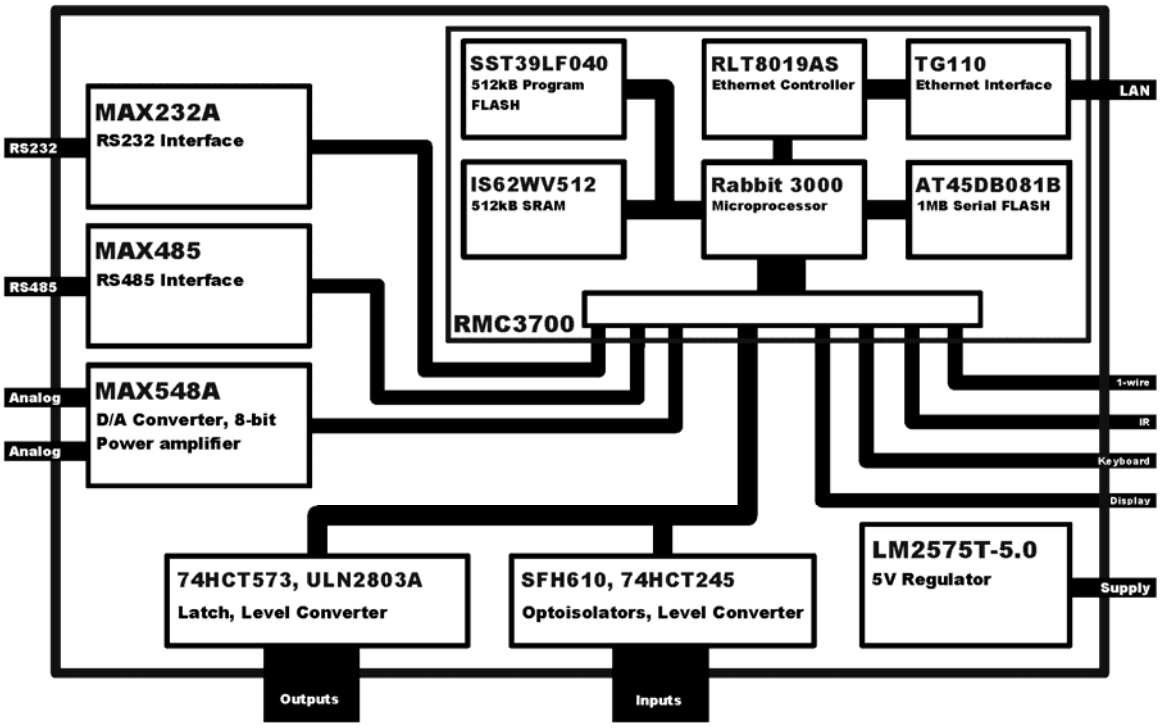

Fig. 1: *SmartHome Block diagram*

Outputs are realised by set of 16 relays with switch contact. Microprocessor store to the latch register represented by 74HCT573 information about switched or not switched proper relay contact. Latch register outputs are connected to the transistor array that subsequently regulates current flown through relay inductors. Inputs are galvanic isolated by 32 optoisolators that are optimised to input range 12÷24 V. Outputs of optoisolators are regularly scanned by microprocessor through 74HCT245 gate. Temperature scanning is realised by digital thermometers DS18B20. Thermometer circuits are connected via 1-wire interface. To one line several thermometers circuits can be connected thereby the number of sensors can be increased. Infra-red diode and infra-red receiver with signal former is also connected to the system. IR components allow the unit to communicate via defined instructions set with compatible device supported RC5 communication standard. To the system belong also small keyboard and 4row LCD display.

3 SMARTHOME SOFTWARE

Program for microcomputer was created and debugged in design environment Dynamic C 9 supported by company Zilog Inc. [4]. Almost the whole program is written in C language [5]. Parts of program with increased demand on precise timing (microsecond units) are written in assembler. The Real-Time Kernel called MicroC/OS-II, created by Jean J. Labrosse is included in this program [6]. MicroC/OS-II is a preemptive, prioritized kernel that allows 63 different tasks, flags, semaphores, mutex semaphores, queues, and message mail boxes. Web pages are written in HTML language. Interactive content of web pages e.g. drawing of measured temperature relations, is created via Java applets and Java script.

4 SMARTHOME CONTROL

Setting up and monitoring of system can be done by different ways. First possibility is local access through keyboard and 4row LCD display which is placed at front panel of the device. Passing through simple menu basic function the system can be set together with displaying of some overview statistics and error messages.

Access from local network or internet is realised through web interface. Internet browser with Java language support should be used for full system access. At the HTML pages the status and statistics data of all inputs and outputs are graphical displayed according to the function which they are assigned. Data obtained from measurements of digital thermometers are displayed as graph characteristics as last day, week or year overview. To the information about temperature also information about regulation of central heating and air condition are joined. Short command history of infra-red remote control, GSM modem and internet access statistic is available as well. Also via web interface setting-up of the system can be done clearly and comfortable. This part of system is of course protected by user defined password.

Remote supervision and control can be also provided with GSM phone. The phone (Siemens C35 is used) is connected to RS232 interface via cable. Data exchange is done via SMS messages. Message communication includes password security. System allows to send information according to the user setting in defined time. Remote control of temperature, switch off or switch on of the outputs and starting of user defined programs are possible as well.

5 CONCLUSION

In very short time the system for intelligent control of houses and flats was developed. The applying of such system is wide as the production of the system will be not very expensive and the construction allows to change it according to the demand very quickly so the system will suit to the demand of individual user.

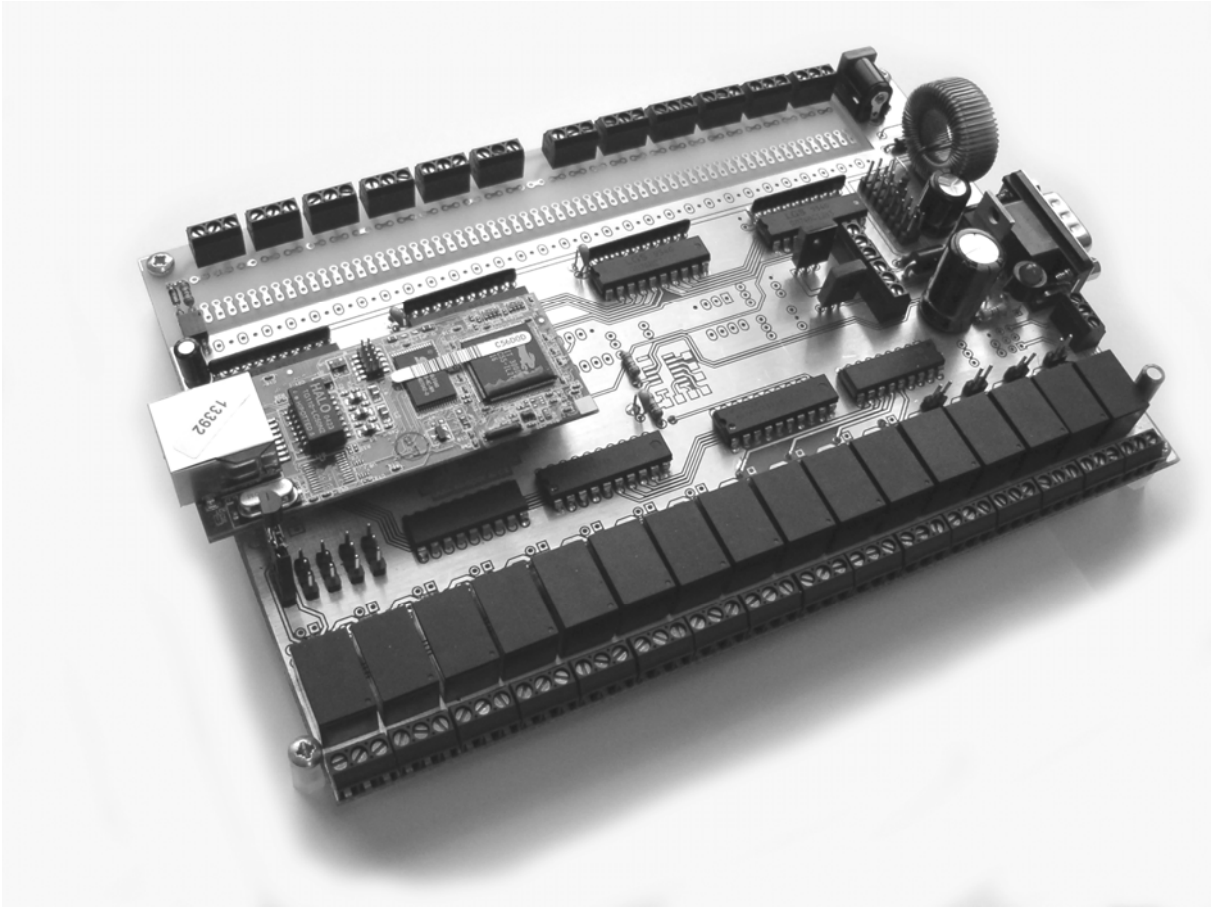

Fig. 2: *SmartHome-I*

ACKNOWLEDGEMENTS

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