One-chip Microcomputer Controlled Handling Appliances

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ABSTRACT: *At present, microcontrollers have found a broad application in various electronic connections. The scope of the use is very extensive and we can find them in circuits for regulation, control, measurement, amusement, etc. In accordance with the type, these powerful microscopic components (with respect to their possibilities) contain in a single box processor, data and program memories, input and output ports, A/D and D/A converters, synchronous serial port, etc.*

All functions performed by this controller are controlled by the program which is inserted in the chip. The controlling program is made by the user himself and thus the functions performed by this integrated circuit are specified.

The parameters of one-chip computer, where a single box contains processor, data and program memories, etc. in a single integrated circuit allow to use this microchip in connections which would be hardly realized by classic integrated circuits. Owing to the use of these fast microprocessor, the connections are realized with a minimum number of the other components.

1 INTRODUCTION

Microcontrollers are more and more used in electronic circuits. Range of their use is extensive and we can find them in circuits for regulation, control, measurement, amusement, etc. These powerful microchip components contain processor, data and program memories, input and output ports, A/D and D/A converters, synchronous serial ports, etc. in a single case.

All functions executed by the microcontroller are operated by the program which is stored in the chip. This controlling program is made and debugged by the user himself and thus the functions executed by this integrated circuits are specified. Completed program can be stored to the memory of microchip via serial port of PC by the aid of programming unit. If necessary this program can be updated. Reprogramming can be carried out ether electrically (EEPROM) or by UV radiation (EPROM).

The parameters of one-chip computer allow to use this microchip in connections which would be hardly realized by classic integrated circuits. Owing to the use of these fast microprocessors, the connections are made with minimum number of the other components.

2 CHARACTERISTIC OF PIC MICROCONTROLLERS

Microcontrollers alias also one-chip microcomputers contain in a single case all significant components of microcomputer :

- Control and arithmetic units,
- Program memory which is either ROM, EPROM, EEPROM or FLASH type,
- R/W type data memory sometimes supplemented by EEPROM memory,
- Peripheral circuits for data input and output.

Microcontrollers include usually clock signal generators and other technical means, such as circuits for correct function checking, circuits for code memory programming in direct application, A/D and D/A converters, program interruption elements, DMA units, etc. For final application, microchip shall be supplemented by power supply circuit, by circuits for power components, circuit for external oscillator and sensing circuits.

Microchip Company is the first worldwide manufacturer (Figure 1) which 8-bite microcontrollers are based on RISC architecture. Present 8-bite microcontrollers (series PIC18Cxxx, PIC16C5x, PIC16Cxx) represent the most advantageous price to performance ratio in this category. On the market there is available a broad range of representatives in individual types which mutually differ by implemented technical means, by the capacity of EPROM (EEPROM, FLASH) and RAM memories, by number of pins, frequency range, type of oscillator, case type, by temperature range, etc. Numerous properties for all types in the given series are the same or similar.

Figure 1 – Example microcontrollers

These microcontrollers contain single-chip and do not require any external components incl. memories. Microchip Company strictly observes the RISC rules (Reduced Instruction Set). Their data and program memories are separated (Harvard architecture). The internal system is characterized by minimum need of external circuits and thus the final application is cheaper. The program itself is very economic, program memory has an optimized width of word (12 - 16 bites) and so the address or direct operand is a part of this program. Furthermore this represents significant acceleration. All instructions except jump instructions are formed by one cycle. Almost all reserved registers, flags and all ports are mapped to the data memory and are accessible by the same methods as users data memory. Addressing is direct, indirect or relative. Instructions can operate directly in the data memory, bite oriented instructions are also available. Two-way integrated circuits are operated by individual bites

3 FUNDAMENTAL PROPERTIES

- Rate up to 10 MHz (max. 33 MHz, 100 ns/instruction), this design allows very low, even zero timing frequency,
- Technology CMOS, power supply in most cases 2.5 - 6.25 V, made in categories Commercial, Industrial, Automotive,
- Integrated circuits have 6, 12, 13, 20, 33 or 52 pins, outputs have high current-carrying capacity: 25/20 mA/pin, 40 mA/port and so allow also a direct excitation of LED,
- Current consumption is very low, typical values : 2-5 mA at 5V and 4 MHz (according to the type) or 1-3 mA in SLEEP mode, at 3 V and at temperatures from 0 - 70^{o}C
- Rate, performance, reliability, even without external components, low price.

4 PROGRAMMING OF MICROCONTROLLERS

Programming of microcontrollers is carried out in assembler by the aid of set of instructions. During this programming valid rules and programming procedure shall be observed. For this purpose, applied symbols and variables shall be defined as well as the location where to store the program in the memory, the end of the program, etc. Source program is translated to hexadecimal shape in program medium (Figure 2), e.g. in MPLAB and further transferred to the memory of microcontroller by the aid of programming unit, e.g. by PISTCART which can be connected to the serial port of PC.

Prior its final programming to the chip, prepared program for any application can be simulated at simulator, e.g. at MPSIM which simulates the operation of the real microcontroller. It can respond on

changes at inputs and show how the outputs are set. It is able to demonstrate the values in working registers in any part of the program and so it is optimum, to make any corrections or adjustments in the debugged program by the aid of simulator. Because a simulator operates neither in real time nor in real environment, it is not sufficient to make and simulate program for the operation of microcontroller but it is necessary to check the given application during operation. The chip with program can be directly installed to the required equipment.

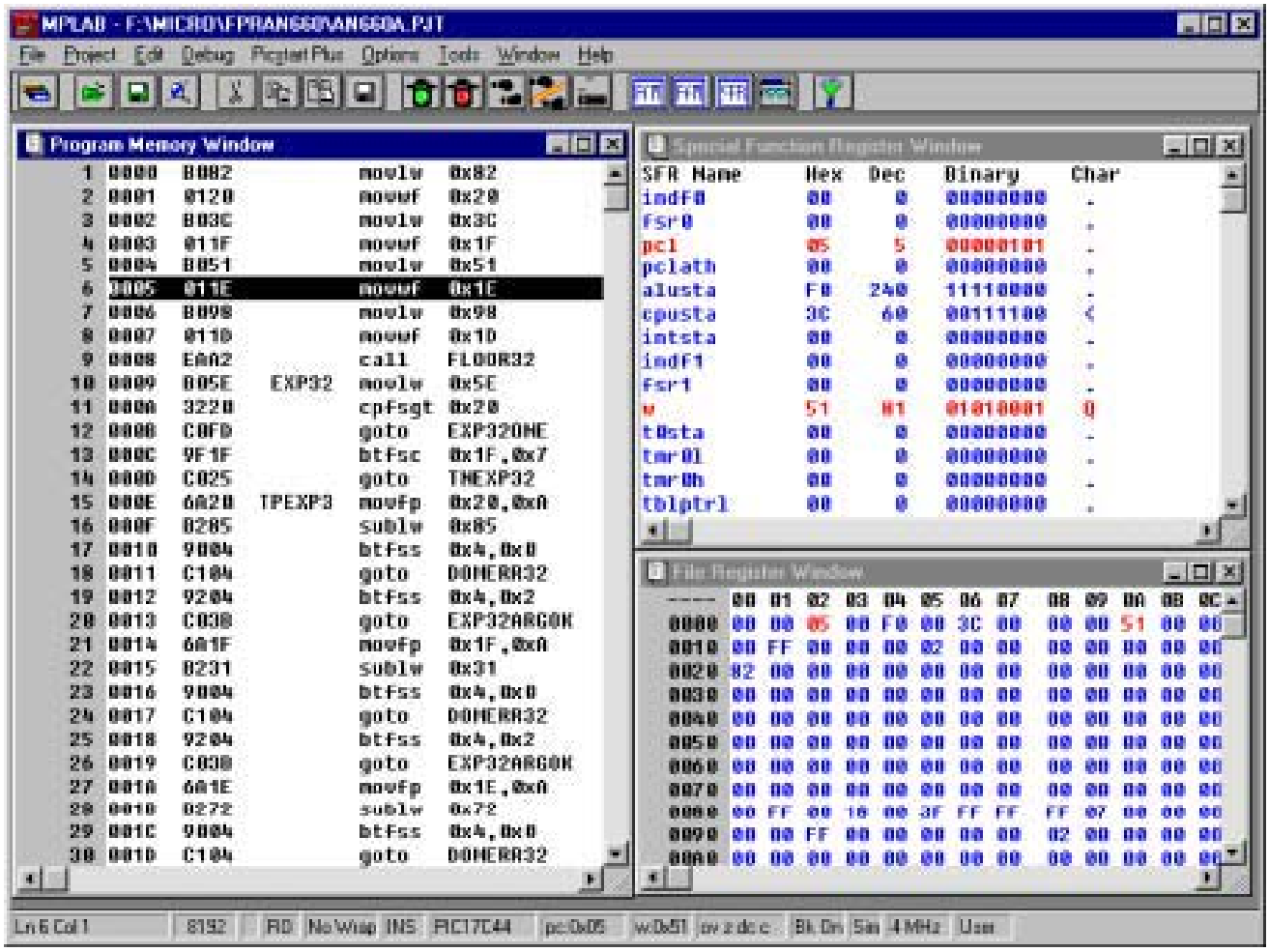

Figure 2 – Program medium MPLAB

5 IMPLEMENTATION OF CONTROL ALGORITHMS IN MICROCONTROLLER

Risc architecture of microchips contains reduced set of instructions which represent simple operations for data transfer in individual registers and fundamental arithmetic and logic operations. The applications of microchip in control system require to create the whole number of routines which are not included in this set of instructions.

6 APPLICATION

This project is aimed at the control of handling appliance by microchip series PIC 16C84. Fundamental components of this equipment are ready, the other parts are prepared at present. The handling appliance in question is shown in Figure 3. It is made of components of SMC company including its manual control (Figure 4). Present result includes handling device control. Further works are aimed at the installation of appropriate sensors and at the programming of microchip system for the diagnostics of failures or errors in controlled device including displaying such failures to the user at alphanumerical LCD. The parts of the project being prepared at present are described in the following chapters.

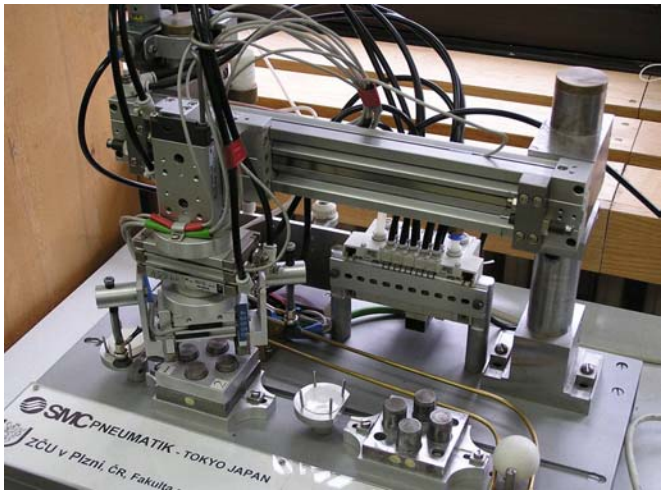

Figure 3 – Handling equipment.

Figure 4 – Control unit - manual/PIC.

6.1 Handling equipment control by PIC

Layout of control unit which allows to replace classic industrial programming automatic machine.

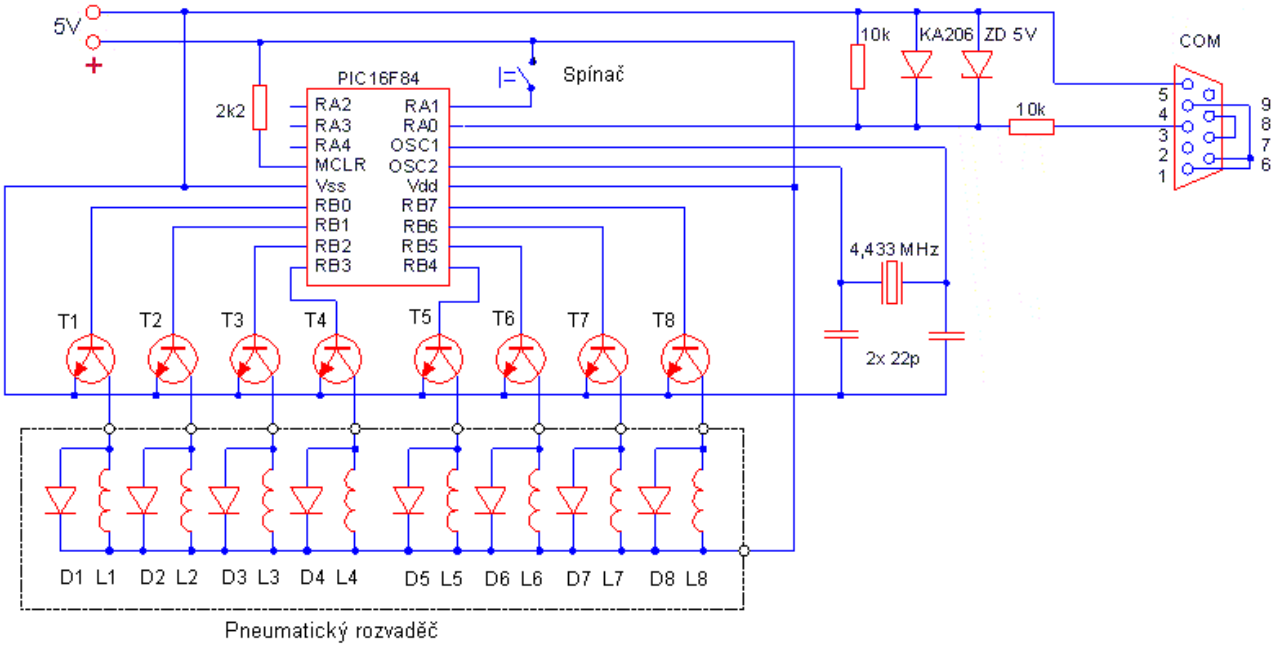

Figure 5 – Layout of control circuit of handling equipment.

Description of handling equipment control is shown in Figure 5. Microchip controls the set of pneumatic distributors (D1, L1 - D8, L8) via power transistors (T1 - T8) either by its own program in the circuit with PIC or by the aid of a switch which actuates control regime by the aid of PC.

Switching among control systems serves for failure cases or in another accidental events. In such a case the chip can be put in or out of operation, or during change of handling cycle when switching to control regime is executed via PC. The advantage of this connection is two wire control at a distance of several meters.

6.2 Replacement of control PIC with other program

The change of handling cycle can be performed in a few minutes either by installing PIC with new program or by reprogramming of the chip directly on the equipment.

The project solves an immediate change of handling cycle by replacement of control microchip in a form of ISO cards. Electronic system with interface in Figure 6 is controlled by the program which is stored in the microchip. Operation cycle is stopped if push button is pressed and the user is asked to replace PIC with another handling program. This solution gives a possibility to debug PIC software.

Operator receives program for the shift in a form of chip card, which is put to the slot on the equipment. The chip card further offers the possibility to identify operator by the equipment itself and thus to avoid to start the equipment by any unauthorized person. At the same time it allows to evaluate the efficiency of the equipment in service.

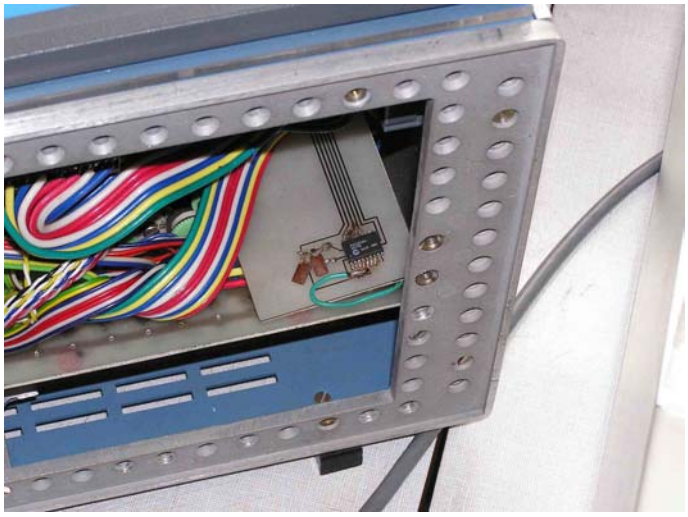

Figure 6 – Electronic system with interface

6.3 Connection of alphanumerical LCD

LCD display unit allows alphanumerical communication between handling equipment and its user. Displayed information relate to the program course, testing points or to error reports which are required for further diagnostics of handling equipment.

The connection is simple. Its main part represents MPU PIC 16F84A which is connected to LCD with 4 bite communication (Figure 7) incl. piezoelement which indicates push buttons pressing and also reports any error condition.

Figure 7 – Display LCD of handling equipment

7 CONCLUSIONS

The project parts presented in this contribution confirms that single-chip computer represents widely used electronic component in such applications where the range of control functions is previously known. A great choice of microchips offered by different manufacturers allows to select an optimum type for the given application. Its use requires to develop control program and test it on the device which simulates the function of single-chip microcomputer (emulator). This step allows to perform necessary reprogramming in a case of program error. Such microcontrollers include memories EPROM, EEPROM or FLASH types, which memory content can be erased. At present numerous manufacturers offer programming means for single-chip microcomputers, however their description and applications exceed the range of this contribution.

In fact, PIC microcontrollers are suitable for all embedded applications, for operation in real time, flexible control, evaluation, design of peripheries, intelligent decoders, drivers, etc. Their high

performance allows to use them in such areas where short time ago their applications for high-quality replacement of parallel circuits, e.g. usual TTL circuits or small gate fields were impossible. Besides technical parameters, further aspects are also important:

- low prices,
- market availability,
- high quality, cheap and easy mastered design and development means, rich libraries of functions and applications,
- offered technical and application assistance

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