Industrial Controller with Built In Tester

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Abstract: *There the author presents an industrial controller on the base of 2 microprocessors – MC6800 and I8051.The general idea is to use a test keyboard like a service device and like a customer keyboard. It isn't necessary to use special test instruments. All service activities are included in the system PROM.*

Keywords: *Controller, Microprocessor, RAM, PROM, PIA, Dynamic indication, Test keyboard, Service functions, System programs.*

INTRODUCTION

The existing controllers are offered without power supply and programming options, as usual [1, 2]. It is necessary to buy a separate supply (common for all system) and test equipment for programming options. In addition, to start the custom program after the corrections you need to uncouple the tester. After discovered errors you have to connect the tester again and repeat the procedure. As usual the test keyboard can't be used like a client keyboard, mainly for economical reasons (the test equipment is too expensive).

The program in the controller EPROM is transferred to the tester RAM and after that it is tested. It is necessary because the stop points are set by SWI instruction, i.e. by replacing the original instruction with SWI. All this shortcomings trouble the work of the service and adjusting staff.

FORMULATION OF THE PROBLEM:

The first problem - power supply of all system is offered like a pulse module [1] because of the big dimensions of the linear block. But it is too difficult to avoid the electrical noises after a current shock in AC supply system. The linear supplies have better characteristics, but for small currents. That is why it is offered a small linear supply for each module with a good noise filtration.

The second problem is adjusting the client programs. The additional test equipment would be solved very elegantly if we include test functions (TF) in the controller programs (CP). For example we could separate controller programs at 2 parts: PROM for POST functions and EPROM for client functions.

The DEBUGGER programs are included in the first PROM. They are elaborated especially for the controller. There is a bit TEST/WORK, who separates the training of the test and the work procedures. By that way there is not necessary to use separate test equipment and an additional test keyboard. We would be able to use an additional test keyboard if we won't, of course.

To use the CP for adjusting client programs or for its servicing you need to include an option "Stop Address" for the program counter. This option allows stopping the program, written in EPROM, without inserting new instructions.

The third problem is extended controller options. The minimum configuration includes 2 modules – controller module and optional module with common purpose. To extend the controller options we would add a host bus (like ISA or PCI in PC), who allows connecting the additional modules to the main module.

VARIANTS OF SOLUTIONS:

Block-diagram of the microcontroller module, according to the conception of part 2, is presented at fig. 1.

The linear supply solves the first problem. In the microcontroller block (MCB) the following 2 problems are solved. It includes Microprocessor module, RAM, PROM, EPROM plus host bus. The Timer has options to work with low clock frequency, as in the industry they work with seconds, minutes and hours. MCB in the offered module is on the base of 2 microprocessors – MC6800 and I8051 (SMD version) – both are in an instrumental performance.

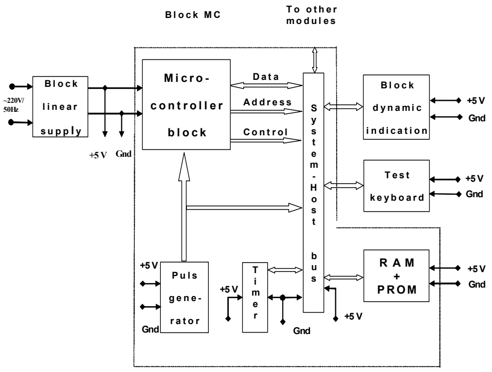
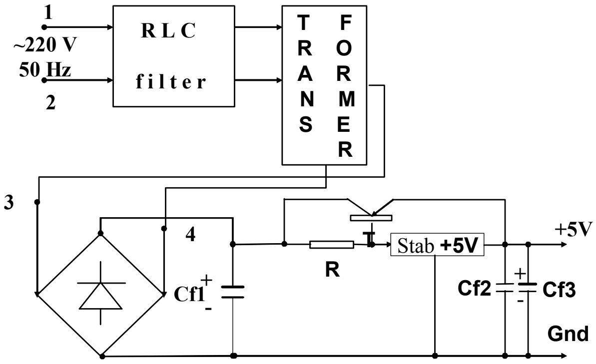


Fig. 1 Block-dlagram of the controller

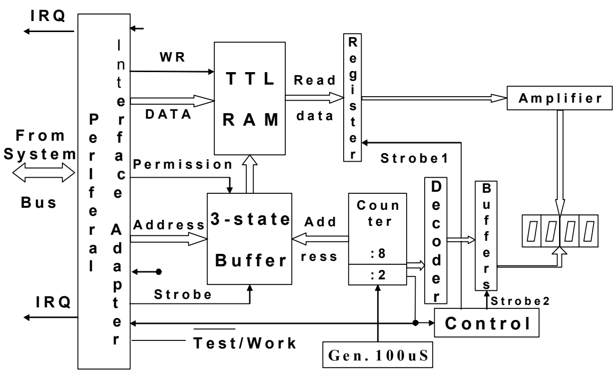


Flg. 2 Linear supply Block

1. The linear supply at fig. 2 is with 30% reserve to feed the minimum controller configuration. RLC filter with high quality is applied in the represented diagram. A power amplifier [1A < It < 3A] is added (T, R). Cf1 and Cf3 are electrolytic capacitors and allow dU ≤ 50 mV. Cf2 reject the high-frequency noises.

If we won't to use common RLC filter and transformer, then inputs 1 and 2 connect itself with inputs 3 and 4, respectively.

2. Block-diagram of the dynamic indication is showed at fig.3. The driver isn't presented.



Flg. 3 Dynamic Indication

The Peripheral interface adapter (PIA) makes the communication between the indication and MCB. The display data are in direct segment code. ASCII code is converted by CP in 7-segment code (the list is elaborated for the controller). The display shows 31 symbols and 10 ciphers. The last data are saved in TTL RAM 8x8.

The counter has 2 parts: by 2 – division and by 8 - division. The pulse after 2-division is used likes IRQ to MCB. The first half of the pulse displays the former data and the second half loads the current data in RAM

.

The control signals Strobe 1 and Strobe 2 display the current symbol. It is given from TTL RAM for REGISTER. The signal Strobe 2 suspends the display in the moment of changing the numbers to avoid the recovering of the symbols.

The signal TEST/WORK controls the programs of the module - showed at fig 6.

3. Block-diagram of the test keyboard presented at fig. 4:

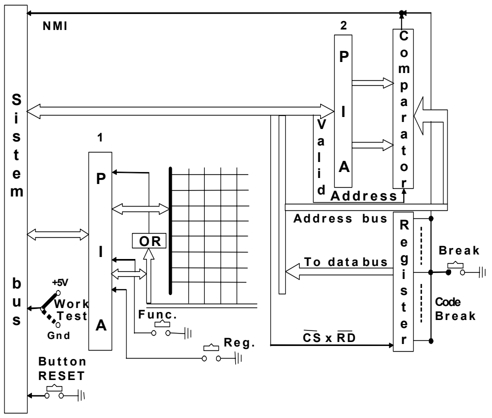


Fig.4 Block of Test keyboard

The most efficient key structure is the matrix architecture. There is realized a matrix for 32 keys. Two keys are connected direct: Register and Function. By this way we can 128 key combinations. Usually they cover all client requirements. Besides a button RESET is joined to the bus. NMI (no masked interrupt) signal is connected with button BREAK (to stop no statutory MCB reactions). The pushed key activates element OR and sends IRQ to MCB by PIA1.

The same PIA gets a number of the pushed key. The key-driver in CP gathers up the key vibrations; catch the falling and the rising front.

The switch S1 forms a signal TEST/WORK for MCB (see fig.3). Block PIA2 realizes the function STOP ADDRESS by the comparator. A button BREAK puts a code "BREAK" to block Register, which sends it to MCB (to distinguish BREAK from STOP ADDRESS).

4. Block-diagrams for MC6800 and I8051 are showed on fig.5a and fig.5b, respectively.

Block DECODER in MC6800 – architecture separates the address space. The free CS# signals are included in the HOST BUS. PROM – block has 2 parts: system PROM (8 kB) and custom EPROM (32 kB). The useless address space might be occupied from RAM, PROM or peripheral chips. MC6800 – block makes signals –WR and –RD (according to the RAM signals) from the original R/-W, as the clocks Φ1 and Φ2. In the both diagrams Clock 20 ms allows reaching big time intervals.

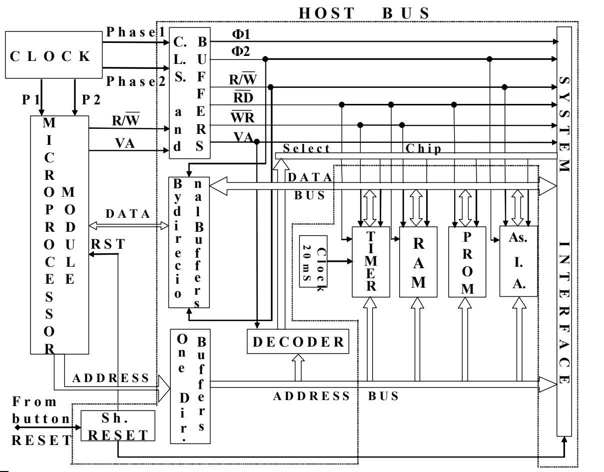


FIg. 5a Block Central Processor Unit with MC6800

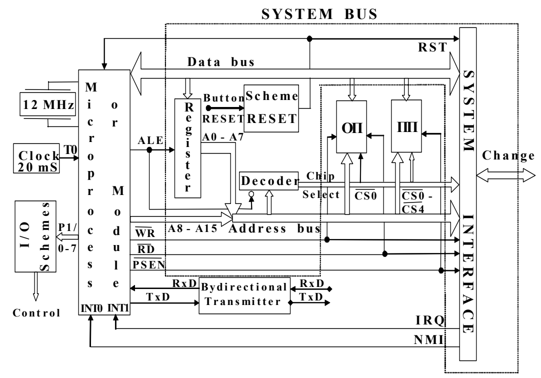


Fig.5b. Block-diagram CPU, based on Intel 8051

Fig. 5b presents the configuration with Intel 8051. Block Register stores the addresses A0 – A7 to free the bus for Data signals. I8051 has a built in full duplex RS232. That because there is added only bipolar converter. As well there are 2 separate address spaces (one for RAM and other for EPROM), the control signals are different for RAM and EPROM (-WR, -RD, -PSEN). That of cause the addresses is recovered self.

However, I8051 has 2 time bigger address space. Besides I8051 permits usage of 8 I/O digit signals. It is better than MC6800 about the hardware. But MC6800 has smaller programs, which are speeder than the same program in I8051.

5. Block – diagram of the Controller programs is presented at fig.6:

The structure of PC is such that all programs are united in one algorithm.

The initialization procedure put on all adapter functions of the module and the test keyboard. After this Monitor has 3 main functions in mode TEST: to process the pushed key, to display the new information, to signalize for errors and display massages.

Debugger has the following options (table 1):

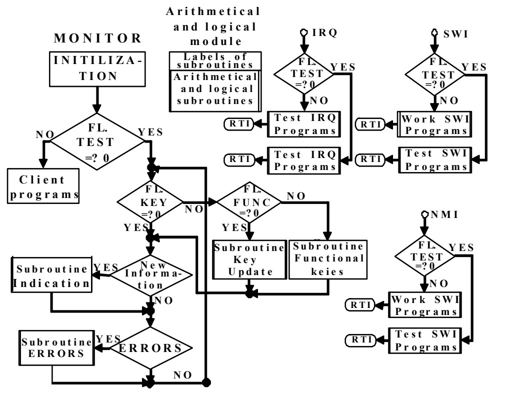


FIg.6 Programe Set of the Controller

Table 1

Left	Moves the cursor left in the symbol positions;
Right	Moves the cursor right in the symbol positions;
Up	Increases the address counter with 1;
Down	Decreases the address counter with 1;
Step	Executes the subroutine step by step;
Go	Starts the program from the entered address;
Act. B.P.	Activates a Break Point;
Vis. B.P.	Displays a Break Point;
Clr All	Clears all interrupt points;
Stop Addr.	Stops the program in assigned address;
Esc	Alternates passing from address to data field and opposite;
Mode	Selects the modes: Display the internal registers or Work with programs and data.

The represented functions permit easy service. The connection with PC is realized by RS232 protocol in asynchronous mode. Maximum exchanged bytes in one session are 4 kB. The client has possibility to add EPROM -–programmer to the host bus.

The client programs have the following restrictions:

- the main program is putted on a constant beginning address;
- the client NMI, IRQ, SWI, RST drivers must begin from a constant address;
- the data area of RAM can't overwrite the service area.

The arithmetical module is composed like the client programs – each function has a constant address. This module has the following actions: 4 arithmetical options at 6-digit numbers with fixed comma, rooting, logarithm, calculating decibels and percents, calculating 5 most used formulas in test and measuring equipment, Binary to Decimal Conversion and Decimal to Binary Conversion.

The Industrial Controller includes 2 modules: Micro-controller module and optional module.

The Optional module has 1 ADC input, 1 DAC output, 16 digital I/O, graphical Display 2x16 symbols.

CONCLUSIONS AND FUTURE WORK

The power noises are minimal, as each module has an own supply.

The 7-segments indication and the keyboard are the same in both modes: TEST and WORK.

It isn't necessary to use test equipment for service and adjustment.

The CP is very flexible: only replacing one chip EPROM you can change entirely the functioning of the controller.

Two MCB are offered to complete the Industrial Controller.

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