

INTERFACE MODULE FOR MOSSBAUER SPECTRAL ANALYSIS

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The Mossbauer Analyzer is designed to register spectrums of non-recoil resonance absorption of gamma rays photons – Mossbauer spectrums. The interface module, that is to be presented works as a multi-counter of pulses generated by a registering analog module and also stores and transfers data to a personal computer.

Keywords: CPLD, interface module

1. INTRODUCTION

The main electrical schematic of the newly designed interface module of the Mossbauer spectral analyzer is presented on fig.1. Strong requirements are defined for the speed of counting and this brings the need of using a CPLD (Complex Programmable Logic Device) matrix. The one that is chosen is from XILINX of type CoolRunner XPLA3. Its operating voltage is 3.3V but the inputs are 5V tolerant. Available macrocells are 256 and they are not enough for storing the collected data. Four 8KB memory ICs (Integrated Circuit) of type HM6264 are used to deal with this problem. The read/write access time is 70 ns. Those four ICs are arranged to form 32 bits word and they are addressed, read and write simultaneously.

The synchronizing clock for the CPLD matrix is provided from external 10MHz quartz generator IC. A JTAG connector is available on the PCB board for programming the matrix. One more connector is placed on the board. It provides data for controlling the “window” position, during registration of an amplitude analysis. The “window” filters the pulses on the base of their amplitude and it could be also set manually from the analog module.

Specially designed state machine is implemented in the CPLD to handle the incoming data from the analog module and register a spectrum. Reading and transferring of the spectrum to personal computer is performed by an AT90S8515 microcontroller from ATMEL. It also controls the state machine's operation.

For driving the lines and adjusting the TTL voltage levels of the built in serial interface to those of the PC's serial interface according to the RS232 standard an external additional MAX232N IC is used.

2. INTERFACE MODULE IN MOSSBAUER SPECTRAL ANALYSIS MODE

Let's focus on the state machines implemented in the CPLD. The registration of Mossbauer spectrum starts when a logical one is applied to the 'Start' signal and logical zero to the 'Reset' signal. Then the counting of the pulses in either of the two

32 bits counters starts with the first positive edge of the frame synchronizing 'F' signal.

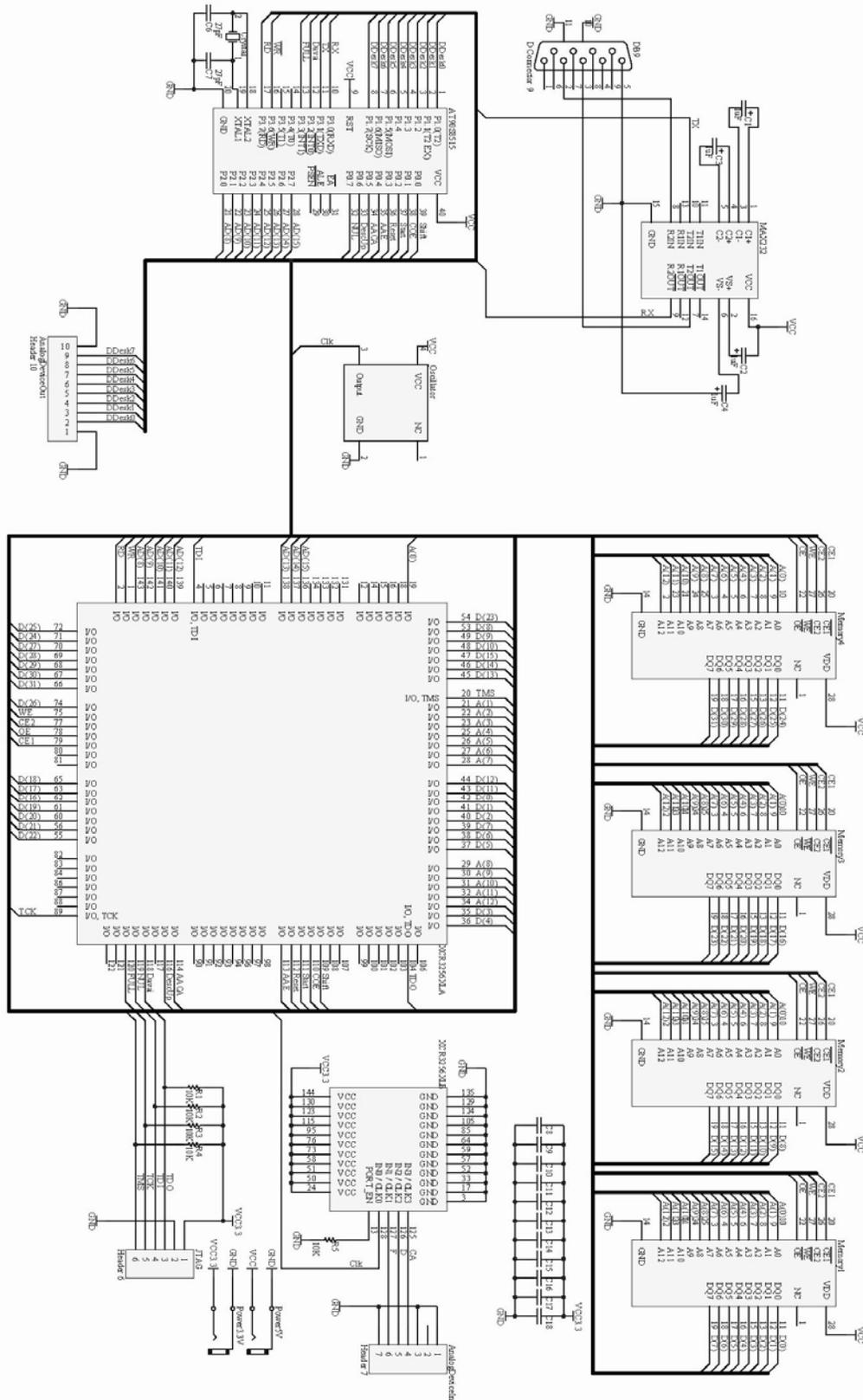


Fig.1 Electrical schematic of the interface module

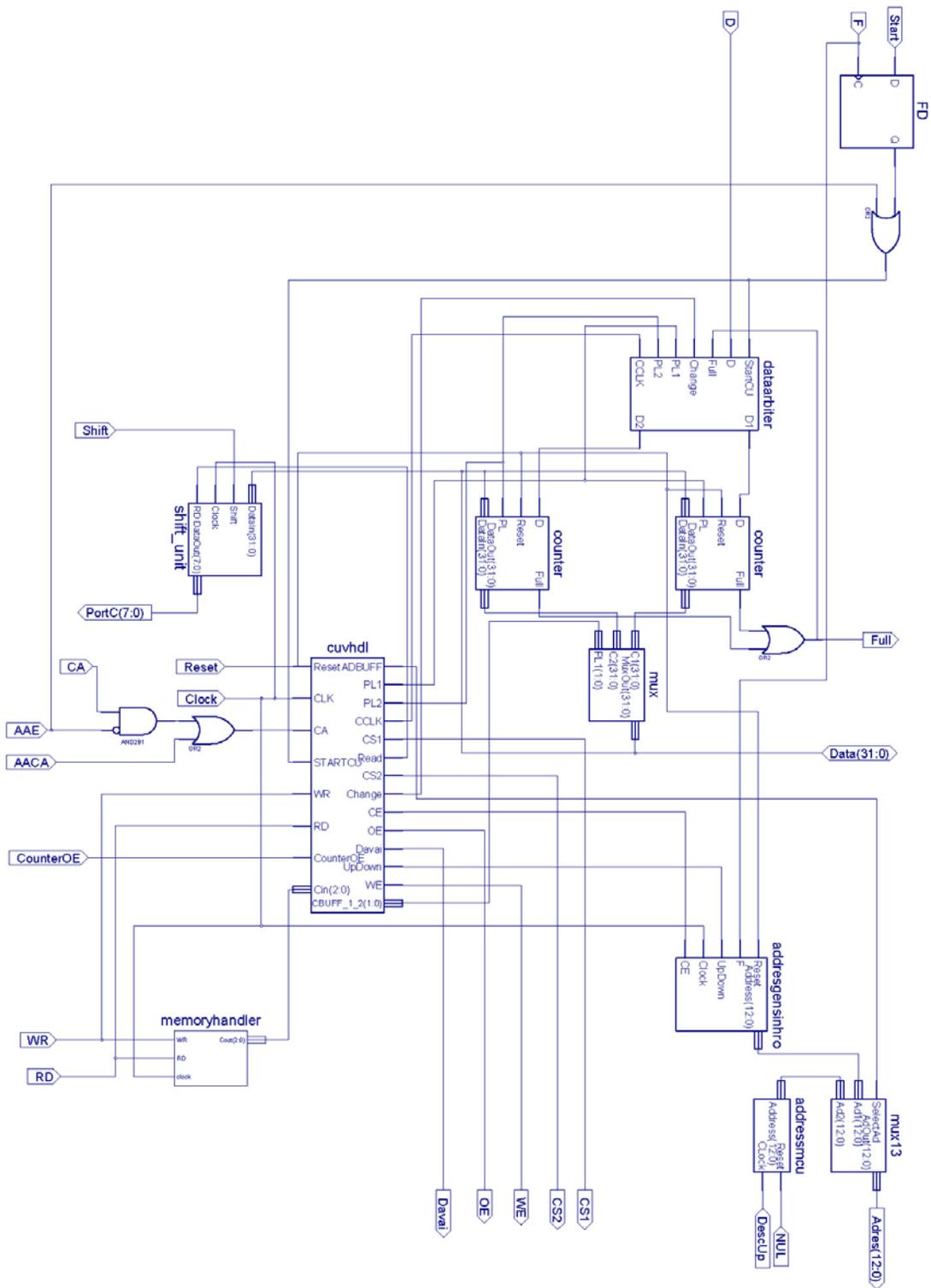


Fig.2 Block diagram of the state machine in the CPLD matrix

On the first positive edge of the new-channel synchronization signal ‘CA’, the counting is switched to the second counter. The logic, implemented in the

'dataarbiter' block, takes care, so every pulse is counted only once when such switching occurs and the pulse length is longer then the switching time.

Then the value in the first counter is stored by one of the state machines, implemented in the matrix in the current memory address. Then a new address that corresponds to the coming channel is selected and its value is transferred to the first counter. With the next positive edge of the 'CA' signal, the counting of the spectral pulses will be switched to the first counter. The value in the second one will be stored in the memory and he will be loaded with the next channel's value the same way as it was previously described.

The memory addresses are generated by a 13 bits counter, described in the 'adresgensinchro' block. The registration of Mossbauer analyze could be stopped by applying a logical zero to the 'Start' signal and it is also synchronized with 'F' signal.

3. INTERFACE MODULE IN AMPLITUDE ANALYSIS MODE

Before a Mossbauer analyze could be performed, an amplitude spectral analyze should be registered. It gives a common spectral view of the material that is to be investigated. The analyze resolution is one hundred channels with manually set "window's" width from the analog module. The time for counting pulses is set from the pc software and is the same for every channel. The way the amplitude analyze is started and stopped doesn't differ from the one for Mossbauer analyze and was previously described.

In this case the pulse counting for every new channel starts with the positive edge of 'AACA' signal. It is generated from the microcontroller after the predefined time for counting pulses in one channel passes and the microcontroller changes the "window" to the next channel. The timetables that correspond to the process of Mossbauer spectrum registration are presented on fig.3 and those for amplitude analyze - on fig.4. For either of the two analyses if one of the 32 bits counters overflow, the pulses will be stopped and the microcontroller will pause the spectrum registration. The Mossbauer analyze channel has duration of 5 μ s. The time needed for writing the counter's value to the memory and loading the counter with new value takes 1,6 μ s. The remaining time before the next cycle of writing and reading is 2,4 μ s. During this period of time the microcontroller can read a random address in memory. A logical one on the signal 'Davai' gives permission to the microcontroller to access the memory by generating an interrupt vector. The microcontroller specifies the address by the 'addressmcu' block and gets the 32 bit value through the second state machine, implemented in the 'cuvhdl' block. The 32 bit value is stored in the 'shift_unit' block and is read by the microcontroller at four times. Once more the date is transmitted at four times to the personal computer that has initiated the memory reading operation.

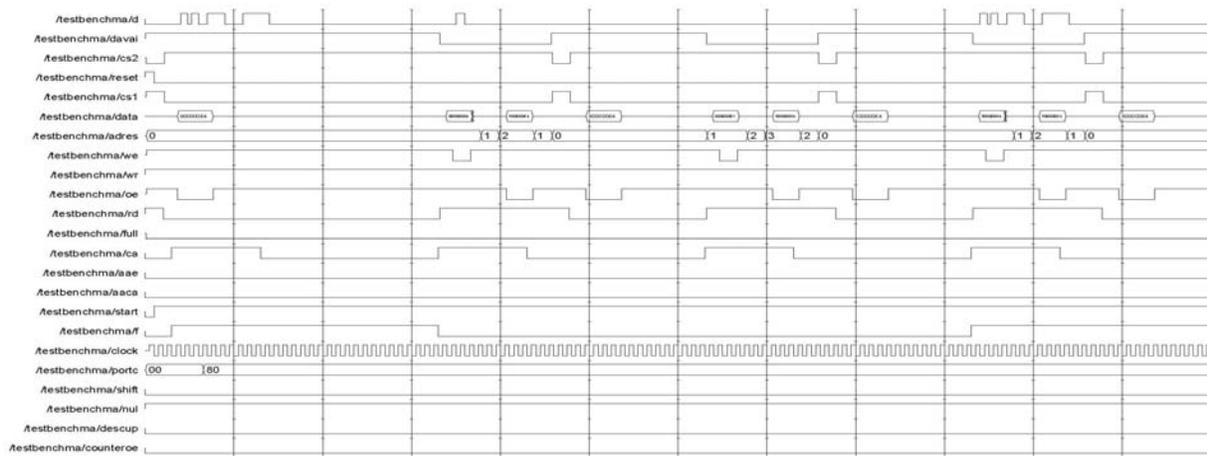


Fig.3 Timetables for Mossbauer spectrum registration

In general the two analyzes are performed mainly by the two state machines in the CPLD matrix. Nevertheless, they are managed by the microcontroller and it plays an intermediate role by connecting the interface board with the personal computer.

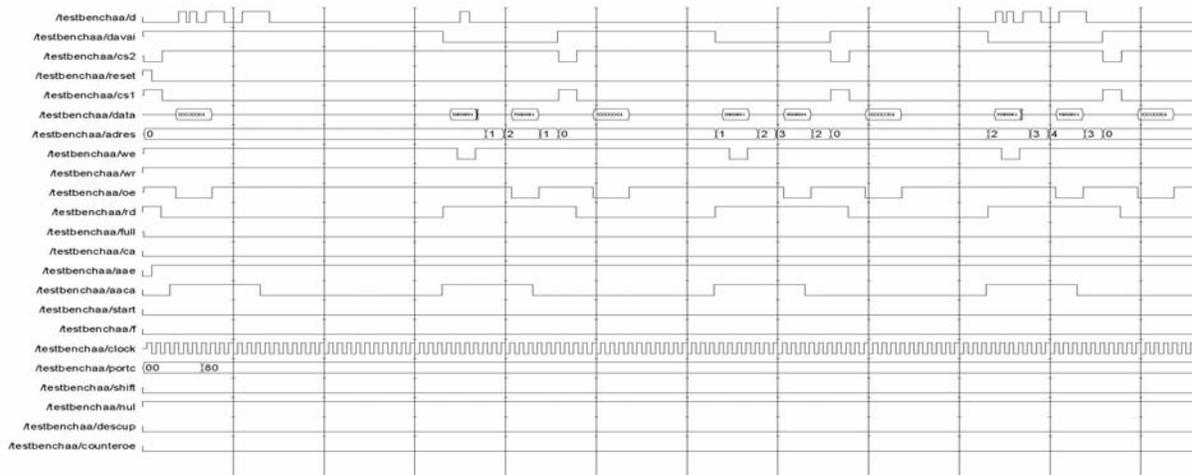


Fig.4 Timetables for amplitude analyze spectrum registration

4. DESCRIPTION OF THE MICROCONTROLLERS PROGRAM

The core of the microcontroller and the peripheral blocks are initialized first. Then the whole RAM memory is initialized by writing zeros at every address through the CPLD matrix and after that the program goes into an infinite loop. In this state the microcontroller responds only to commands send from the personal computer through the serial interface. When a byte is received, the interrupt vector redirects the program to a subroutine named 'Receive'. If there is no parity error, a command identification procedure starts. If the received byte is not recognized as a command, a predefined value for error is send to the personal computer. If a command is recognized, then the corresponding operations are performed and a confirmation byte is send back after finish. With this mechanism both analyzes are started and stopped, information regarding the state of the interface module is obtained and the memory is

initialized. When either the two analyzes is to be read, four bytes are transmitted sequentially for every channel and after every four bytes the personal computer returns information if the transmission was errorless. If there was an error, the four bytes are transmitted once again. If there is an error in five consecutive packets of four bytes, the transmission stops. When a reply from the personal computer is expected, a timer is started and if the predefined time goes out without the answer to be received, the transmission also stops.

5. CONCLUSION

The newly developed system could be used for:

- comparative analyze of different spectrums for discovering of changes in the material structure;
- gathering of data and its transmission trough a communication network to a processing center. This functionality is available, because both the software analyze module and the interface module could be connected to a modem through RS 232 interface;
- control of the presence of “weak” radiation. In this case the system could be realized on portable computer and analyses “on the field” could be performed.

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