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Implementation of 8 Bit Microcontroller Using VLSI

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Abstract
VLSI is a promising field in the current development of world in the technology aspects. Microcontroller is a fundamental one which has a complete system on a single chip. The main purpose of this paper is to realize the basic functions of controller in Spartan 3E kit by interfacing the kit with the computer. Functionalities of basic modules in a controller is programmed in VHDL programming, it is then verified by the simulation results by the model sim simulator. Then the VHDL code is realized using the Spartan 3E XC3S100E by interfacing the input & output with the system through the USB. Also in this paper PWM control is verified using CRO. Important components of this controller is Arithmetic unit, Logic unit, Rotate unit, Shift unit, Memory to read & write the data and Interrupts.

Keywords
VLSI, VHDL, Microcontroller, Spartan 3E, Simulation

I. Introduction

VLSI is known as Very Large Scale Integration, which is all about the fabrication of integrated circuit (IC) in a miniature size. VLSI is the fabrication of ICs in which there will be millions of transistors in a package. VLSI is the one developed rapidly to achieve the main three parameters such as miniaturization (reduction in ship size), reduced power consumption, better speed. VLSI technology has no limit since it is applied in other major areas such as communication, networking, processor based system designs.

Microcontroller is basically known as System on a single chip with internal peripherals of which processor does not have. Microcontroller has some inbuilt features such as internal program & data memory, clock oscillator circuit, interrupts Timer / Counter and serial ports. There are different kinds of microcontroller are available based on the bit such as 8 bit, 16 bit & 32 bit. In this paper the basic functionalities of the controller such as Arithmetic unit, Logic unit, rotate unit, Shift unit, Serial ports for data transmission & reception via serial ports and PWM control are taken and coded using VHDL and realized in Spartan 3E kit.

II. Existing Work

In early days there was a design of simple processor using CISC architecture which performs the simple processing work, since it was designed based on the CISC architecture that has a complex instruction set which takes more memory space and more time to get execute. Then they moved on to the RISC processor that has a simple & reduced instruction set that takes less execution time. Then the research was in the 16 bit & 32 bit processor and its internal architecture analysis. They did their research by coding the processor using VHDL and verified by simulation and later on to the FPGA kit.

In advance to that they had taken their research in to the controller area by implementing the controller functions in the FPGA kit by coding which is done using the VHDL language. In their research at beginning they simply coded the basic functions of microcontroller seperatly such as 8 bit ALU, 16 bit ALU, 32 bit ALU, Universal shifter, etc. But in the later stages of research they had combined all the individual functionalities into a one controller. They verified it by downloading the program into Xilinx kit using JTAG programmer port.

III. Proposed Work

In our project we designed the each & every function of the controller such as arithmetic unit, logical unit, shifter, rotate unit, memory to read & write the data in a particular address, interrupts and serial ports. All the separate functionalities are combined together by calling the each function as subprograms from the main program. The coding are fused into the PROM so that to obtain the program from the PROM at the time of kit initialization.

Here we use serial ports for data transfer to the system through the IO ports. Using this serial port we communicate the Xilinx kit with the PC for giving input using keyboard and displaying the output in monitor using hyper terminal windows. Hence we are using a Xilinx kit as an interface board so as to perform those microcontroller functions.

IV. Modules of Microcontroller

A. Accumulator

Accumulator is the 8 bit register which is also termed as A register which is capable of processing 8 bit data. The accumulator is a basic register where it holds the first operand to perform any operation. The result of any operation stores it results (lower order bits) in the A register. It can also be accessed by the direct addressing by which its physical address is E0H.it is the most versatile register of 8051 controller.

B. Register B

Register B is the second 8 bit register that is used to hold the second operands of 8 bit data which is used for the operation of multiplication & division. It stores the results of those operations where it holds the result of higher order 8 bits.

C. Control Unit

Control unit is a part of CPU. It is to control the flow of data from the CPU to the IO devices. It controls & co-ordinates the communication between devices. It also provides the timing & control signals to the operation to perform. Control unit is to realize the instruction set of CPU. It performs the task of fetching, decoding, execution & storing data. It translates the instruction into micro instruction between execution units.

D. Program Counter

Program counter is to point out the address of next instruction to be executed. It is used when the interrupts occurred, at that time the next address is stored in program counter and responds the interrupts. While returning from the interrupt it retrieves the address from the program counter. It is 16 bit register to store

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the 16 bit address. It can also be used as 8 bit by splitting as PCL (lower byte) & PCH (higher byte).

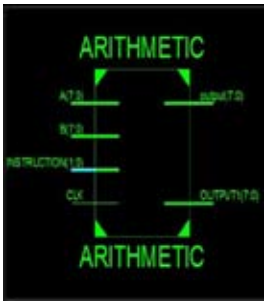
E. Interrupts

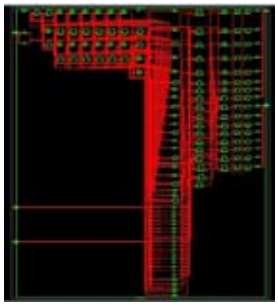
It is a special occurrence of signal to the controller. When the interrupt occurs, the system stops its main program execution & the address of the next instruction to be executed is store in the program counter. After responding to the Interrupts, it returns to the main program by retrieving the address from the program counter.

V. Software Simulation

A. Arithmetic Unit

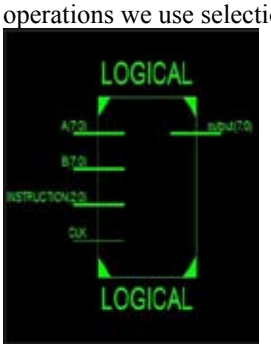
Arithmetic unit is a basic digital circuit that performs an 8 bit arithmetic operation such as addition, subtraction, multiplication & division. The inputs to the Arithmetic unit are from A & B register. The output is stored in the A register. The multiplication is the only operation that results in 16 bit where as others are 8 bit output [1].





B. Logic Unit

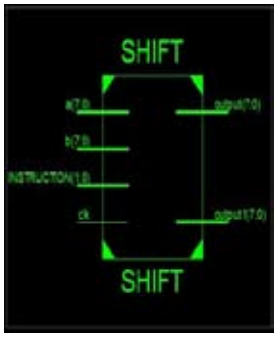
Logic unit is a digital circuit that performs the 8 bit logical operation such as AND, NAND, OR, NOR, XOR, XNOR, NOT. The inputs to the logical operations are from A & B registers. The output of the logical operation is stored in A register. For NOT operation only A register is used as input & output. For performing logical operations we use selection bits to select the operation[1].

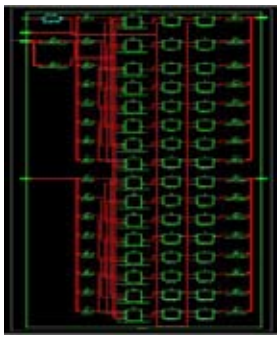


C. Shift/Rotate Unit

Shift/Rotate unit is to perform the shift & rotate operation of 8 bit input from A register. It performs the Shift left & right as well as rotate left & write. In this operation we use selection bits to select the operation to be performed on the input.

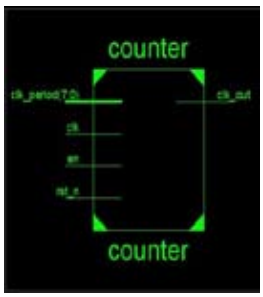
In shift operation, the data are shifted either left or right by replacing the value 0 in the blank bit after shift. In rotate unit the data are rotated within their registers in which the data from the MSB to LSB & vice versa based on operation[1].

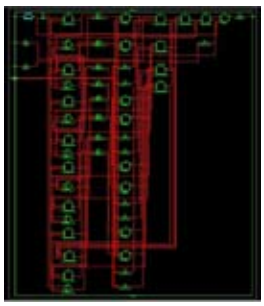




D. Counter

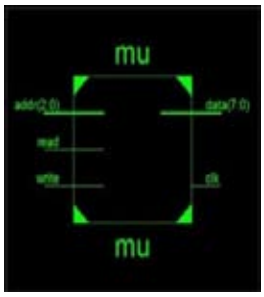
Counter is a digital circuit that performs the counting of external events occurred. We use an 8 bit counter which can be preload with a clock period or preset value. It is a cyclic operation of which keeps on counting on the occurrence of clock signal. In general there are various types of counters are available. But we designed the upcounter which keeps on counting until the preset value is reached. Once the preset value is reached the timer get reseted and starts from the beginning[1].

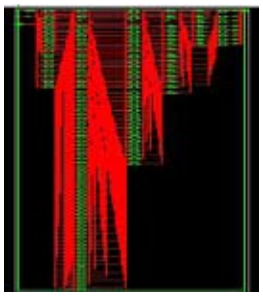




E. RAM

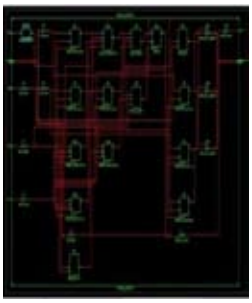
Memory unit is to read & write a data in a specific address. We designed the RAM module of size 128 bytes. The size of the RAM is determined by the size of address. For achieving the 128 bytes of RAM we used the 8 bit address. There are two basic operations available in RAM. One is Read operation & another one is a Write operation [1].





F. Interrupt Controller

Interrupt is occurrence of special signal by which the microcontroller must response the interrupt occurred. Here we use the 3 bit interrupts form which the interrupts are programmed in a different mode. Based on the input and control signals the output is occurred by which the actions can be performed. In this paper we simply designed this unit to generate output depends on the input fed [1].



VI. Hardware Descriptions

A. Power Supply

The power consumption by the FPGA kit is 5v DC. Hence first we use the transformer to step down the 230 v into 12 v AC supply using step down transformer. Then the 12 v AC is converted into 12 v DC using the bridge rectifier circuit. The 12 v is again regulated as constant 5 v DC supply at the output using the regulator IC 7805. The 5v DC supply is given to FPGA kit, Serial communication port to send the data from kit.

B. FPGA KIT

Field Programmable Gate Array (FPGA) is pre fabricated devices which can be programmed as the user needs and the FPGA can be performing as a digital circuit based on the system design. They have many advantages when compared the FPGA with ASIC. ASIC is Application Specific IC. It cannot be re programmed once while the coding are fused into it, where as in FPGA the hardware can be reconfigured using Hardware Description Language (HDL) by download that into the FPGA kit. Another was the cost of production is very less in FPGA while compared with ASIC. But as disadvantages are considered the two things are applications runs slowly and another one was it needs more space (transistors).

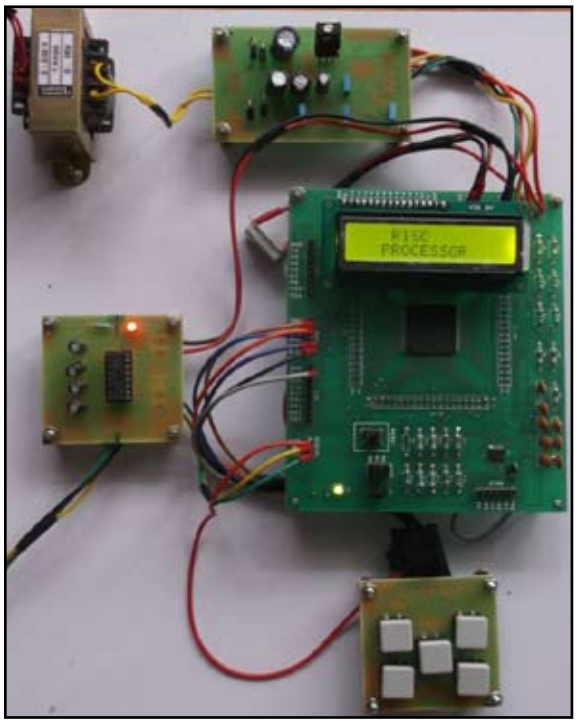
C. LCD Display

Liquid crystal displays (LCDs) have materials which combine the properties of both liquids and crystals. An LCD consists of two glass panels, with the liquid crystal material sand witched in between them. When the LCD is in the off state, light rays are rotated by the two polarisers and the liquid crystal, such that the light rays come out of the LCD without any orientation, and hence the LCD appears transparent. When sufficient voltage is applied to the electrodes, the liquid crystal molecules would be aligned in a specific direction. The light rays passing through the LCD would be rotated by the polarisers, which would result in activating / highlighting the desired characters.

D. RS 232 Serial Communication

In telecommunications, RS-232 is a standard for serial binary data interconnection between a DTE (Data terminal equipment) and a DCE (Data Circuit-terminating Equipment). It is commonly used in computer serial ports. In the circuit the MAX 232 IC used as level logic converter. The MAX232 is a dual driver/receiver that includes a capacitive voltage generator to supply EIA 232 voltage levels from a single 5v supply. Each receiver converts EIA-232 to 5v TTL/CMOS levels. Each driver converts TLL/CMOS input levels into EIA-232 levels.

In the circuit the microcontroller transmitter pin is connected in the MAX232 T2IN pin which converts input 5v TTL/CMOS level to RS232 level. Then T2OUT pin is connected to reviver pin of 9 pin D type serial connector which is directly connected to PC. In PC the transmitting data is given to R2IN of MAX232 through transmitting pin of 9 pin D type connector which converts the RS232 level to 5v TTL/CMOS level. The R2OUT pin is connected to receiver pin of the microcontroller. Likewise the data is transmitted and received between the microcontroller and PC or other device vice versa.



VII. Result

The performance of the controller function was evaluated using the Spartan 3E XC3S100E, TQ 144 xilinx kit. The functions was programmed seperatly as a sub programs and finally fused together to perform the basics controller operations. Based on the key inputs through the key pad, the process is executing and the outputs are displayed through the LCD display. The processed data can also be sent to the PC through the hyper terminal. It is only done when the Serial pin is in enabled.

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