3 Bit Signed Calculator

User Guide

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1 Introduction

The main goal of our project is to make a functional calculator that operates with 3 bit signed integers, in a range of [-8:7]. To input the two operands, we will use the eight switchs available on the board. The eight switches represent the eight bit word, where the 4 most significant bits represent the first operand and the other bits represent the second.

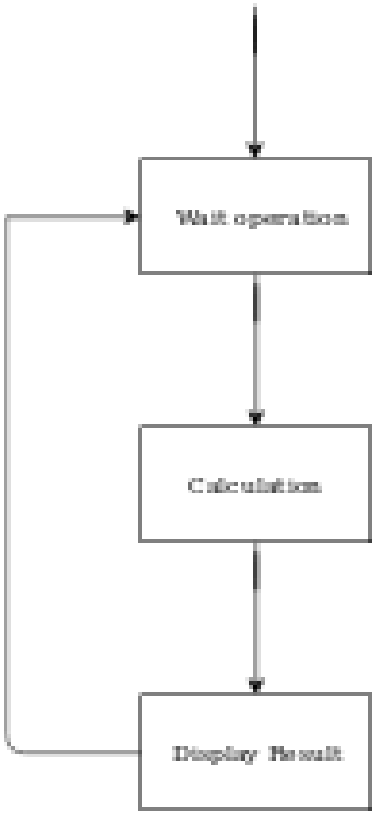

Figure 1: Calculator flow chart

2 Block Diagram

The picoVersat block diagram is shown in Fig. 2. PicoVersat contains 4 main registers: the accumulator (register A), the data pointer (register B), the flags register (register C) and the program counter (register PC).

2.1 Accumulator register

Register A, the accumulator, is the main register in this architecture. It can be loaded with an immediate value from the instruction itself (immediate value) or with a value read from the data interface. It is the destination of operations using as operands register A itself and an immediate or addressed value. Its value is always driven out to the data interface.

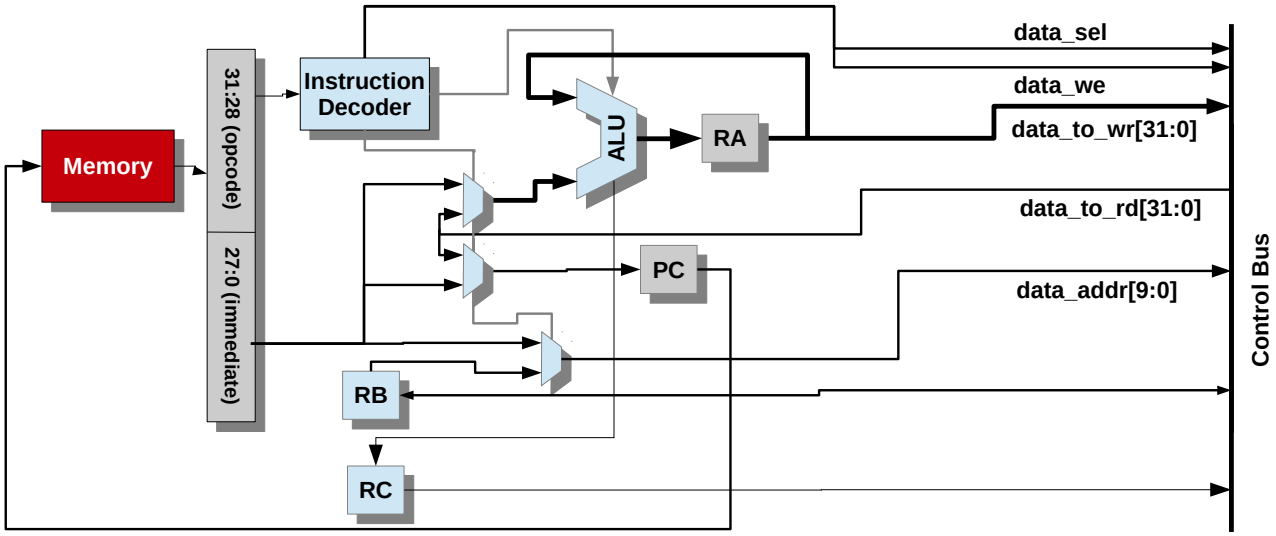

Figure 2: Block Diagram

2.2 Pointer register

Register B, the memory pointer, is used to store the address in indirect loads and stores to/from the accumulator, respectively, and to store the target address in branch instructions. Register B itself is in the memory map so it can be read or written as if accessing the data interface.

2.3 Flags register

Register C, the flags register, is used to store three operation flags: the negative, overflow and carry flags. Register C itself is in the memory map and it is read-only. The flags are set by the controller ALU and can be read by programs for decision taking. The structure of register C is shown in Table 1.

Bits	Name	Description
31-3	NA	Reserved for future use
2	Negative	Asserted if last ALU operation generated a negative result
1	Overflow	Asserted if last ALU operation generated an arithmetic overlow
0	Carry	Asserted if last ALU operation generated a carry

Table 1: Register C: flags

2.4 PC register

The Program Counter (PC) register contains the address of the next instruction to be fetched from the Memory. The PC normally increments to fetch the next instruction, except for program branch instructions, in which case the PC register is loaded with the instruction immediate or with the value in register B, depending on the branch instruction type, direct or indirect, respectively.

3 Interface Signals

The interface signals of the Versat controller core are described in Table 2.

Name	Direction	Description
clk	IN	Clock signal.
rst	IN	Reset signal.
Instruction Bus Interface		
instruction[31:0]	IN	Instruction to execute.
pc[9:0]	OUT	Program Counter (instruction address).
Data Bus Interface		
data_sel	OUT	Read or write request.
data_we	OUT	Write enable.
data_addr[9:0]	OUT	Data address.
data_to_rd[31:0]	IN	Data to be read.
data_to_wr[31:0]	OUT	Data to be written.

Table 2: Interface signals.

3.1 Instruction Bus Timing Diagram

The timing diagram for an instruction read transaction is shown in Figure 3.

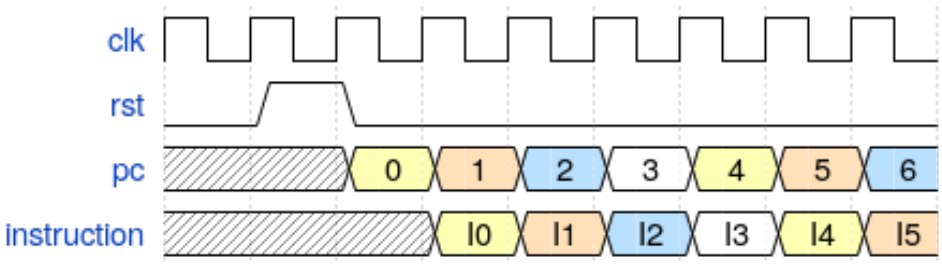

Figure 3: Instruction (pipelined) reads.

3.2 Data Bus Timing Diagram

The timing diagrams for data reads and writes are shown in Figure 4 and Figure 5, respectively. These operations may be consecutive or not, as illustrated.

4 Peripherals

PicoVersat is supplied with two useful peripherals, a general purpose register file and a debug print facility.

A simple System on Chip (SoC) including picoVersat, a program and data memory, and the two peripherals attached to the data bus is shown in Figure 6.

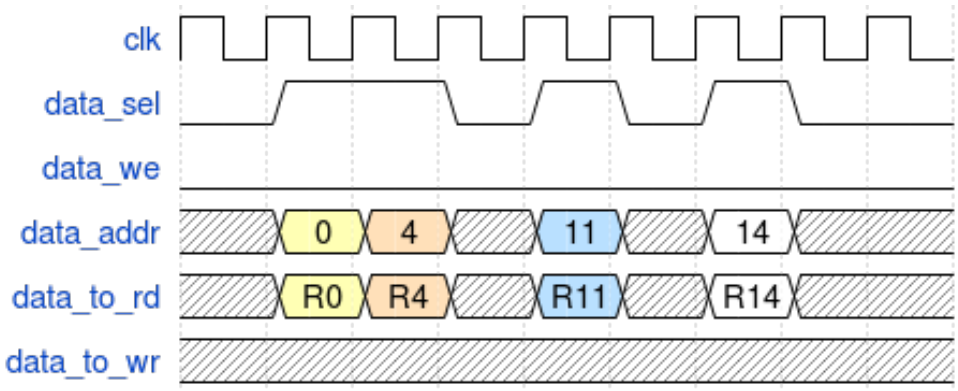

Figure 4: Data Bus reads.

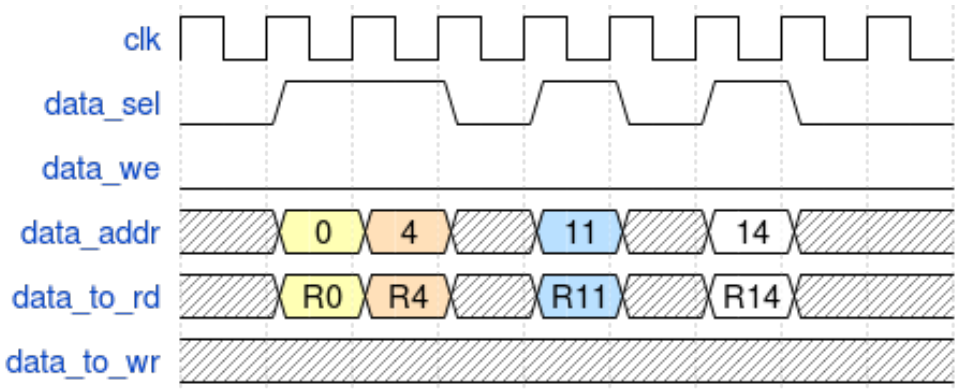

Figure 5: Data Bus writes.

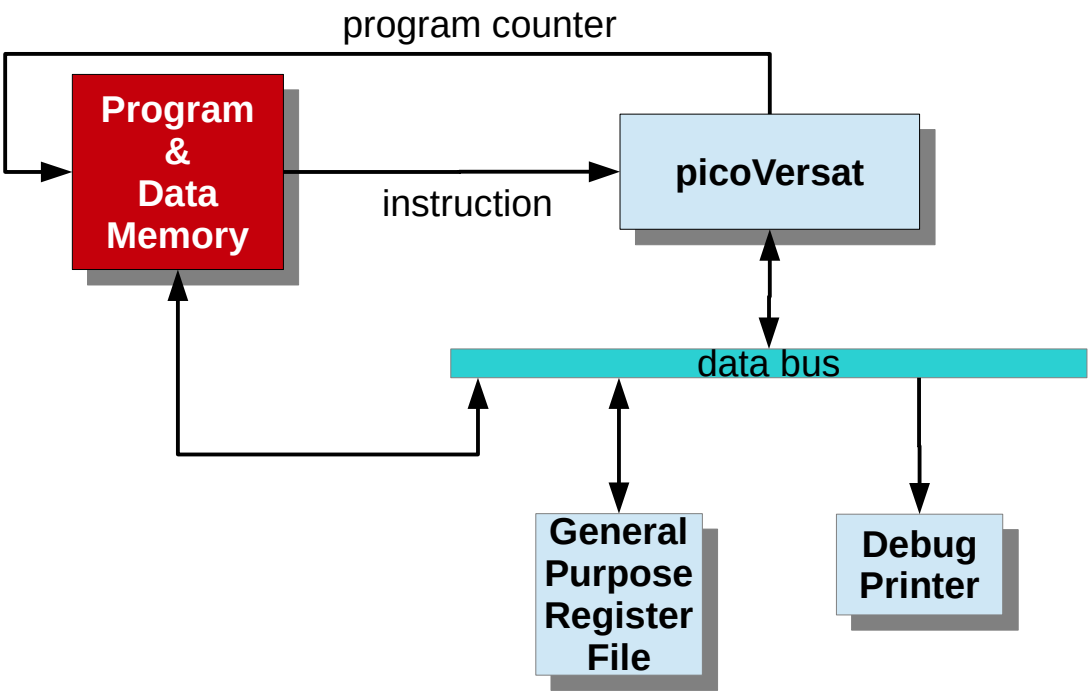

Figure 6: PicoVersat SoC with two peripherals

Refer to the memory map in section 5 to check the base addresses of the peripherals.

4.1 General Purpose Register File

This peripheral contains a 16x32bit register file that can be used by user programs.

4.2 Debug Printer

This peripheral can be used by user programs to print characters, mainly for debug purposes.

4.3 Switches Driver

This peripheral is used to input two operands for the arithmetical operation.

4.4 Push-Buttons Driver

This peripheral is used to select the arithmetical operation.

4.5 7-Segment Display Driver

This peripheral is used to display the result of the the arithmetical operation.

5 Memory Map

The memory map of the system, as seen by picoVersat programs, is given in Table 3.

Mnemonic	Address	Read/Write	Read Latency	Description
REGF_BASE	0	Read+Write	0	Register file peripheral
CPRT_BASE	1	Write only	NA	Debug printer periheral
PROG_BASE	3	Read+Write	1	User programs and data

Table 3: Memory map base addresses

6 Instructions

6.1 Implementation Results

7 Conclusions