Hardware Synthesis, Term Project

Objectives

- Design a simple system on a chip

Background

System on a chip (SOC) has been a trend in several hardware designs. The idea is to include every subsystem (CPU, memory, I/O, coprocessor, etc) into a single chip. The final result is a compact design with minimal delay in datapath. The latest Apple M1[1] is a good example of a system on a chip.

Requirements

In this project, you are asked to design a mini calculator system in FPGA. The interface is your VGA, and either a USB (PS/2) keyboard or a USART input. Please note that you may clone Intel 8051, Intel 8088, Motorola 6502, Motorola 6800 instruction set architecture. There are plenty of cross compiler tools and simulators available.

Your system must support:

- At least 320x240 display through VGA port through memory mapped display. There is no need to show colors. B/W is acceptable.
- USB (PS/2) keyboard or a serial Interface
- Reset switch
- 4 digits of decimal operation (-9999 to 9999), no floating point
- Support (atleast) 4 operations (plus, minus, multiplication, division)
- Display 4 digits output to VGA screen. When the result is overflow (out of range), show the N/A, NaN.
- Accept input from USB keyboard or USART interface

Grading

Given that this is a challenged task, even if you cannot deliver the fully function calculator, you can still get a partial credits as following:

- (10 points) show numbers on the VGA screen. If you cannot show the number to VGA, use 7-segment display (5 points)
- (20 points) support for each operation (plus, minus, multiplication, division) (5 points for each operation)
- (10 points) show proper/modular design of the system (ALU, display module, Serial/USB Module)
- Bonus. (5 points) graphic design of your screen.

Please submit a short video (no more than 5 minutes) to demonstrate your calculator. The submission will be announced later. The deadline for submission is December 16, 2022.

Plagiarism is not acceptable. You are welcome to discuss the design with your friends. However, please do not directly use your friends' code. Any unacceptable plagiarism will give you up to 30 points of penalty.

[1] https://en.wikipedia.org/wiki/Apple_M1