

Project Title: Floating-Point Arithmetic Unit (FPU)

Short Description

This project aims to design and implement a hardware-accelerated Floating-Point Arithmetic Unit. The FPU will support basic floating-point operations such as addition, subtraction, multiplication, and division, following the IEEE-754 single-precision standard (32-bit format). The system will receive floating-point numbers through an SPI interface and provide the computed results via SPI output.

Technical Details

Core Functionality:

Floating-Point Arithmetic Logic

Implements IEEE-754 single-precision (32-bit) arithmetic.

Supports operations: addition, subtraction, multiplication, division, probably also exponential, and square root.

Uses hardware-based bitwise operations, normalization, and rounding to ensure accuracy.

SPI Communication Interface:

Uses SPI protocol to receive two floating-point numbers and an operation command.

Implements an SPI slave module to handle input and output transactions.

Result Output Options:

Send computed results via SPI back to the microcontroller/PC.

Add error detection for underflow, overflow, and invalid operations with LED representation.

I/Os

Inputs:

SPI interface (MOSI, SCLK, CS) to receive floating-point numbers and operation selection
clock input

Reset button to clear the FPU state

Outputs:

SPI interface (MISO) to send back computed results.

LEDs for error indicator

Hardware Peripherals Required

SPI master device (Microcontroller or PC, need to figure out) for sending floating-point inputs

LED indicators for error detection

Module Header

```
module floating_point_unit (  
    input logic    clk,  
    input logic    rst_n,  
    input logic    spi_cs,    // SPI chip select
```

```
input logic    spi_mosi,    // master-out, slave-in (input from microcontroller)
output logic    spi_miso,    // master-in, slave-out (output to microcontroller)
output logic [X:0] error_leds    // error indicators
);
```