EE2993: Interface Control Document

Carter Belog, Caroline Rooney

October 2024

1 Microcontroller Pin Assignments

The microcontroller (MCU) utilized shall be an ESP32-C3-DevKitM-1U. The pin assignments for connecting the MCU to the data acquisition (DAQ) circuitry is as follows:

Table 1: MCU Pin Assignments

Pin Name	Pin No.	Pin Assignment
GPIO0	9	MUX D3
GPIO1	10	MUX D2
GPIO2	4	MUX D1
GPIO3	3	MUX D0
GPIO5	21	ADC CS
GPIO6	22	ADC SCLK
GPIO7	23	ADC CNVST
GPIO8	25	ADC BUSY
GPIO9	26	ADC DoutB
GPIO10	11	ADC DoutA
GPIO20	28	ADC ADDR

2 Software Implementation

The signal outputs from the microcontroller listed above shall be programmed into a real-time plotting application. The design of this application will involve the MCU receiving input signals from the ADC, as described in section 4, receiving a bit-stream, signaling the multiplexer to switch to the next channel, and repeating. The bit-stream will contain the necessary information for the real-time plotting and analysis being performed by the MCU.

The inputs the MCU is outputting from GPIO pins 0-3 are the signals for which channel of the multiplexer shall be fed through to the output. This allows multiple signal values to be accepted from a single pin. The value that is being fed through to the mcu can be decoded in software using indexing and keeping track of which input is currently being read.

Section 5 outlines the order of which the MCU will cycle through the channels. This order can be hard-coded into an array whose indices will assign the proper variables for the plotting application.

3 Multiplexer Channel Assignments

The multiplexer (MUX) shall utilize the following channels, which represent the listed signals:

Table 2: MUX Channel Assignments

MUX Channel	Device Signal
1	Output 4
2	Output 3
3	Output 2
4	Output 1
9	Attenuator 4
10	Attenuator 3
11	Attenuator 4
12	Attenuator 4
13	Source 4
14	Source 3
15	Source 2
16	Source 1

4 High-Level DAQ Sequence

The software sequence for the DAQ process shall proceed as follows:

1. On startup, the MCU shall initialize the MUX to turn on Channel 1.
2. Following initialization, the MCU shall, after a 3 second delay, begin carrying out the cyclic DAQ process outlined below, continuing until device power is removed:
   (a) MCU calls ADC to begin conversion
   (b) MCU delays for 0.5μs
   (c) ADC sends bit-stream to MCU
   (d) MCU delays for another 0.5μs
   (e) MCU calls MUX to switch to next channel
   (f) MCU delays for 0.5μs
   (g) Sequence Repeats
3. Upon shutdown, the MCU, MUX, nor ADC shall carry out any controlled shutdown procedures

5 MUX Channel Cycle

The MCU shall call the MUX to cycle through the relevant channels in the following order:

$$1 \rightarrow 2 \rightarrow 3 \rightarrow 4 \rightarrow 9 \rightarrow 10 \rightarrow 11 \rightarrow 12 \rightarrow 13 \rightarrow 14 \rightarrow 15 \rightarrow 16$$

These channels are called via binary references using the MUX digital input pins as outlined below:

Table 3: MUX Channel Calls

D0	D1	D2	D3	On Channel
0	0	0	0	1
1	0	0	0	2
0	1	0	0	3
1	1	0	0	4
0	0	0	1	9
1	0	0	1	10
0	1	0	1	11
1	1	0	1	12
0	0	1	1	13
1	0	1	1	14
0	1	1	1	15
1	1	1	1	16

6 Digital Comparison

An additional software application shall be a graphical user interface that allows a user to adjust the starting conditions, and probabilities the same way the user can adjust them on the hardware interface with potentiometers. Behind the GUI shall be a digital application for solving nonlinear differential equations, in this case, the predator prey equation. There shall be a real-time plotting interface for comparison to the solution the analog computer calculates. Both the plotting interfaces will be digital, so in the case of the analog computer's plot, the results will be rounded by the value for $\epsilon_{machine}$ of the MCU and DAC.